



CHEMICAL ENGINEERING

September
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Reducing Emissions

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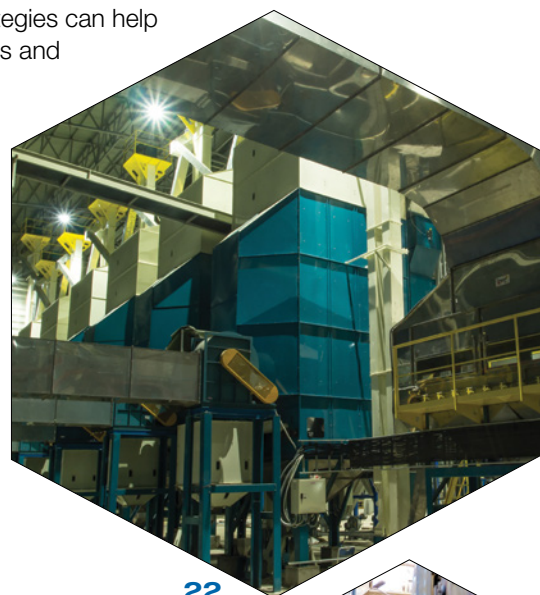
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Recycling plastics

Separating recyclables from our trash has become commonplace for many of us. What can be recycled and how it is collected, however, varies quite a bit by location. My town, for example, accepts plastics #1 (polyethylene terephthalate; PET), #2 (high-density polyethylene; HDPE) and #5 (polypropylene; PP). Other locations accept plastics #1–7, which includes low-density polyethylene (LDPE), polystyrene and others. Some towns collect plastics together with metals and glass, and others do not. This variation in collection protocols in the U.S. can be confusing to consumers and is one of the big hurdles to advancing plastic recycling.

A recent report [1] from the National Academies of Sciences, Engineering and Medicine (www.nationalacademies.org) finds that private- and public-sector recycling efforts are not well coordinated and says that “action from the public sector at the federal, state and local levels is needed to improve the plastics waste-management system in the U.S.” The report states that recycled plastics are an underutilized resource, and that only about 10% of plastics waste is recycled in the U.S.

Using recycled plastics

The National Academies report summarizes a study that was sponsored by the U.S. Dept. of Transportation and the U.S. Environmental Protection Agency to look at the potential use of recycled plastics in infrastructure. Potential infrastructure applications include asphalt pavement mixes, drainage pipes, railroad ties, bicycle paths, composite utility poles and highway sound barriers. Of these, only drainage pipes shows significant demand at present, according to the report, and more knowledge about a number of factors, including long-term performance, is needed for further adoption. The four plastics with properties that are most suited for infrastructure applications — PET, HDPE, PP and LDPE — are also in demand for applications such as carpeting, clothing and bottles. The report says that more recycled plastics are needed to meet the demand.

Processing technologies

As the demand for recycled plastics increases, companies are investing in processing technologies and facilities. Nova Chemicals Corp. (www.novachem.com), for example, recently announced that it is developing its first mechanical recycling facility to convert post-consumer plastic films to recycled polyethylene (rPE) at commercial scale as early as 2025. The facility, to be located in Connersville, Ind., is expected to deliver over 100 million lb of rPE by 2026.

Nova has also announced that it, together with Plastic Energy, will study the feasibility of developing a pyrolysis-driven advanced recycling facility for polyethylene in Ontario. If built, the facility is expected to be the largest of its type in Canada. Advanced, or chemical recycling, can produce plastics with the same properties as virgin material.

Late last year, ExxonMobil Corp. (www.exxonmobil.com) announced the successful startup of its advanced recycling facility in Baytown, Tex. The facility is said to be able to process 80 million lb/yr of plastic waste.

More news on recycling facilities and technologies can be found in “The Latest” section on our website (www.chemengonline.com) and by subscribing to our free “Sustainability Direct” E-newsletter. ■

Dorothy Lozowski, Editorial Director

1. National Academies of Sciences, Engineering and Medicine, Recycled Plastics in Infrastructure: Current Practices, Understanding, and Opportunities, Washington, D.C., The National Academies Press, 2023.



Direct-air capture of CO₂ via a liquid-based, low-temperature, thermochemical system

Edited by:
Gerald Ondrey

With global temperatures likely to rise beyond the 1.5°C target set by climate experts, negative emissions technologies — most notably direct air capture (DAC) — become increasingly important for addressing CO₂ already in the atmosphere. A new DAC approach is being pursued by Holocene Climate Corp. (Knoxville, Tenn.; www.theholocene.co). Holocene's system is unique in its ability to operate at low temperatures, while still employing an aqueous-based approach amenable to traditional chemical-engineering scaling benefits.

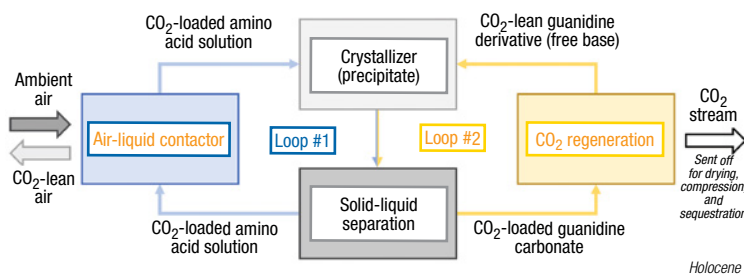
Leveraging technology licensed from Oak Ridge National Laboratory (ORNL; Oak Ridge, Tenn.; www.ornl.gov), Holocene developed a process with two distinct chemical loops (diagram): in the first, an amino acid solution is used to absorb CO₂ from the air with an apparatus that is similar to the air-liquid contactor in a cooling tower. In a second step, guanidine compounds are added to the CO₂-rich solution, forming an insoluble carbonate salt. The much lower solubility of the guanidine carbonate salt, compared to its guanidine precursor, drives the process and results in a solid, CO₂-containing

precipitate. The solid material is filtered and heated (110°C) to release the CO₂, which is then sent on for further use or sequestration.

"Having two distinct loops increases the robustness of our process and lowers the energy requirements," explains Holocene co-founder Keeton Ross. "We can keep the amino acids away from heat, where they would degrade. Also, we are able to heat only the solid to regenerate CO₂, rather than wasting energy heating a large volume of water."

The amino-acid markets are mature, and Holocene is focused on scaling up production and optimizing the performance of their guanidine derivatives.

Holocene has working bench-scale versions of all DAC unit operations, and is currently building its first integrated facility — with capacity of around 10 ton/yr CO₂ — for planned commissioning at the end of 2023. This will be followed by the design of larger, commercially available facilities.



Holocene

'Printing' new catalyst candidates onto a chip

Discovering new catalysts and materials for specific applications can be a tedious and time-consuming process involving labor-intensive tests and expensive samples. Technology developed by Mattiq (Skokie, Ill.; www.mattiq.com) enables the "printing" of tens of thousands of tiny material samples onto a single chip for comparison against a reference material. "We can screen the materials for their electrochemical activity very quickly, but we can also take the chip and subject the entire chip to accelerated stress testing because one parameter we really care about is durability. In just a few hours, we can determine which materials might degrade under certain conditions," explains Andrey Ivankin, chief technology officer and co-founder of Mattiq. Currently, the technology is being used to investigate potential alternatives to the costly iridium-based catalysts used in proton-exchange membrane (PEM) electrolysis. "We can

quickly go through two- or three-element species and compare them side by side with the reference material on the chip. If we find promising candidates, we can scale them up to milligram and gram scales, and we can integrate them into onsite PEM electrolyzers for further testing. We have built the electrolyzer infrastructure in house to prove that the material works as we observed on the chip," says Ivankin.

What sets Mattiq's methods for material discovery apart is the combination of scale and complexity of materials that can be synthesized onto the chip. "We can create 10,000 discrete materials in ten minutes. Many other methods rely on thin films instead of discrete materials, but that isn't how those materials are used in electrolyzers and reactors, and the properties can differ once they are in the application," says Ivankin. "We've really created an end-to-end pipeline for materials simulation, synthesis, exploration and testing," he adds.

STEAM REFORMING

Honeywell International Inc. (Charlotte, N.C.; www.honeywell.com) and ZoneFlow Reactor Technologies, LLC (ZFRT; Windsor, Conn.; www.zoneflowtech.com) have successfully conducted pilot-plant testing of the ZoneFlow Reactor in ZFRT's large-scale pilot plant at Université Catholique de Louvain in Louvain-la-Neuve, Belgium. The near-commercial-level testing validated increased steam-methane-reforming (SMR) capacity by at least 15% in terms of feed flow compared to conventional state-of-the-art pellets, with no higher methane slip and without increasing the maximum tube-skin temperature or pressure drop. This increased production of H₂ allows for the reformer to convert hydrocarbon feeds, such as natural gas or naphtha, and steam into synthesis gas (syngas).

In 2021, the two companies signed a joint development agreement to grow and commercialize the ZoneFlow Reactor technology. This technology can provide a significant improvement in the productivity and cost-effectiveness of SMR for H₂ and syngas production (see *Chem. Eng.*, December 2021, p. 5).

NEW MEMBRANE

Wastewater from food-processing, tanneries, textile processing, paper mills, pharmaceuticals and other industries often contain a mixture of salts and organic material — often nutrients and other valuable by-products — that cannot be separated and recovered by conventional treatment methods, such as reverse osmosis. Although conventional nanofiltration and electrodialysis can be used for desalinating the organic-rich wastewater, the combination has separation efficien-

(Continues on p. 6)

cies of 90–95% and is very prone to membrane fouling. Now, an international team of researchers has developed a thin-film composite (TFC) nanoporous membrane (NPM) that is said to improve the performance of electrodialysis, achieving separation efficiencies of more than 99%, while consuming less energy.

The new membrane and its performance is described in a recent issue of *Nature Water*, with authors from the Dept. of Chemical Engineering at the University of Bath (U.K.; www.bath.ac.uk), along with colleagues from China, South Korea, Singapore, Australia and Belgium.

The new membrane system uses TFC nanoporous polyamide membranes as anion-conducting membranes to replace conventional anionic exchange membranes (AEMs). The surface properties of the TFC NPM are engineered by co-deposition of polyethyleneimine and polydopamine (PDA), a compound mussels excrete and use to stick to rocks or wood in wet conditions. This bio-inspired coating intensifies the charge-shielding effect to enable fast ion transfer, and thus improve separation with reduced fouling.

ORGANIC BATTERY

Last July, the world's first operational Organic Solid-Flow Battery was delivered to the hybrid wind and solar park Schattendorf in the Burgenland state of eastern Austria. The battery storage system was manufactured by CMBu Energy Alzenau, Germany; www.cmbu.com), and Burgenland Energie is the hosting electric utility.

Organic SolidFlow batteries do not require critical raw materials, such as lithium or cobalt, nor do they use metal ions. Instead, the system uses an organic electrolyte that combines both flow and solid-state technology.

Built in early 2023, the hybrid photovoltaic (PV) park in Schattendorf has

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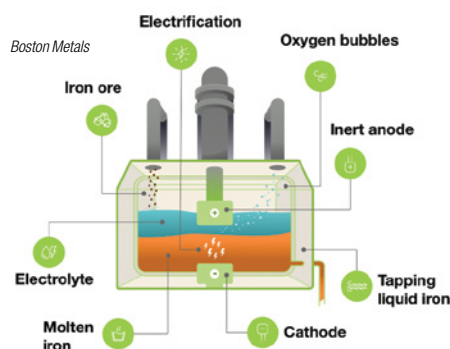
This electrolysis cell produces high-purity iron

Processing iron ore is the most carbon-intensive step in the steelmaking process, often using coal as an energy source. A new technology, called Molten Oxide Electrolysis (MOE) aims to decarbonize the iron-ore process through electrification. “In the MOE cell, an inert anode is immersed in an electrolyte containing iron ore, and then it is electrified. When the cell heats to 1,600°C, the electrons split the bonds of the iron oxide in the ore, producing pure liquid metal. No CO₂ or other harmful byproducts are generated in this process, just oxygen,” explains Adam Rauwerdink, senior vice president of business development at Boston Metal (Woburn, Ma.; www.bostonmetal.com), the developer of the MOE process. The pure metal produced in the MOE cell can be directly integrated into conventional down-

stream-steelmaking processes.

Both the melting and the reduction steps take place within the MOE cell (diagram). High-density iron collects at the bottom of the cell (at the cathode), while any impurities remain in the less-dense electrolyte phase, which floats above the heavier metal phase. The high-purity metal can be removed from the cell separately from the impurity-containing electrolyte. Because the impurities are separated within the cell, MOE enables the use of lower-quality feedstock than other avenues for steel decarbonization, such as hydrogen-based direct reduction, which requires very pure feedstock and several processing steps. “Lower-temperature, solid-state processes like direct reduction do not involve melting, so the impurities remain within the iron, which must be removed using subsequent melting and refining,” adds Rauwerdink.

The specialized inert anodes form the centerpiece of the MOE cell. They not only enable scalable ore processing with no CO₂ emissions, but also support continuous operation. “While high-temperature electrolysis for high-volume metals production has been demonstrated in the aluminum industry, we are the first company to use the approach for steel,” he notes. Boston Metal is currently working to validate the inert anodes at a semi-industrial scale, with plans in place to pilot the technology with major steelmakers.



A new approach to refrigeration with no global-warming potential

Traditional vapor-compression refrigeration relies on hydrofluorocarbons (HFCs) as refrigerant fluids — a class of compounds with global-warming potentials (GWP) thousands of times higher than that of CO₂. A new approach from scientists at Lawrence Berkeley National Laboratory (LBL; Berkeley, Calif.; www.lbl.gov) demonstrates cooling without the use of high-GWP fluids using what the researchers call the “ionocaloric” effect.

In ionocaloric cooling, ions mixing with a solid material induce a phase transition in the solid by lowering its freezing point, similar to the freezing-point depression that occurs when salt is used to melt road ice. Cooling occurs because the lowering melting point moves through the solid-to-liquid phase transition temperature. “Ionocaloric refers to a thermal response to an applied ionic field, or electrochemical potential,” explains Drew Lilley, co-founder of Calion Technologies, a company formed to develop the technology. Lilley’s co-founder is LBL scientist Ravi Prasher.

To elicit the cooling effect, the salt is mixed with the solid form of the pure solvent ethylene carbonate, which has a melting point around 35°C. The temperature of the mix decreases through the solid-to-liquid phase transition of ethylene carbonate. The temperature decreases to 6.4°C with 23% NaI, the researchers say, with heat absorption occurring to convert the solid to liquid, thus giving rise to a cooling effect.

The key to the technology, however, is making the phase transition reversible. To do that, the researchers apply a voltage to separate the ions from the solvent through a membrane, similar to what occurs in a battery or fuel cell. Separating the ions from the solvent raises its melting point again, and the ethylene carbonate re-crystallizes, releasing heat.

The researchers have built one prototype system, and are working on a larger-scale prototype to refine the ion-solvent separation step. “Our current focus is on improving the engineering,” Lilley says. “We are really looking to flesh out the potential of this kind of cooling for a host of different applications.”

a capacity of 15 MW. The Organic SolidFlow battery that is connected to the solar park comes as a “battery lab” in a 40-ft, thermally managed and location-independent container.

“Our focus for the coming weeks will be to evaluate our technology’s performance and then deliver further storage systems with a total capacity of 300 MWh to Burgenland,” says Peter Geigle, founder and CEO of CMBlu Energy.

VANILLA-BASED RFB

This month, a three-year international project began to further develop redox-flow batteries (RFBs) based on vanillin. The VanillaFlow project, funded within the EIC Pathfinder Challenge of the European Research Council, is being led by Graz University of Technology (TU Graz; Austria; www.tugraz.at), with partners from TU Darmstadt, Ecolyte GmbH, Montanuniversität Leoben and Biobide.

In 2020, TU Graz scientists first demonstrated the feasibility of a vanillin-based flow battery as a more sustainable alternative to those based on critical or environmentally harmful raw material. With VanillaFlow, a prototype will be developed in which all components of the battery are optimized using artificial intelligence (AI) and machine learning (ML) — the vanillin compounds as the storage medium, the membrane, the electrode and the control system.

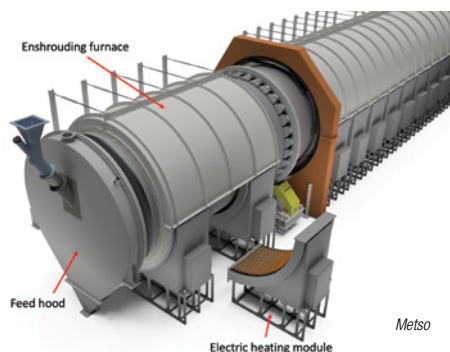
In the case of the membrane and the electrode, the primary aim is to replace the less environmentally friendly materials previously used for this purpose in battery storage systems with sustainable materials as well. For membranes, for example, patent-pending, paper-based membranes are being developed to replace the Nafion membranes used so far.

As soon as a first prototype of this AI-codesigned storage system is ready, it is planned to integrate

This indirectly heated rotary kiln is powered by electricity

Metso Corp. (Helsinki, Finland; www.metso.com) has optimized its existing rotary kiln technology and launched RotarEkiin, an electrically powered, indirectly heated rotary kiln. The electric heating system of the RotarEkiin provides a sustainable alternative to conventional fuel-powered indirect rotary kilns.

The RotarEkiin (diagram) is comprised of modular heating sections that have resistive-heating elements along their inner circumference to heat the kiln shell. This modular design is said to offer superior temperature control over the length of the kiln compared to fuel-fired designs, and can be customized to match specific applications. The modules can easily be removed and exchanged for maintenance and repair.



Traditional indirect kilns combust fuel, creating exhaust gases that carry away heat as waste, explains Maximilian Köpf, director Technology and R&D, BL Ferrous & Heat Transfer at Metso. Because the RotarEkiin does not fire fuel, there is no heat wasted in the exhaust gases. This, combined with the improved flexibility and control of the shell temperature leads to a decrease in energy consumption of nearly 50%, he says.

The RotarEkiin is available with kiln-shell diameters of up to 5 m — the largest commercially available electric kiln, says the company. It can be used for low- to medium-temperature processes (up to 850°C). Potential applications include lithium acid roasting, rare-earth-acid roasting, pyrolysis (carbonization), low- to medium-temperature calcination and drying. Throughputs depend on the process itself, but for a lithium-extraction, acid-roast process, Metso has considered the RotarEkiin for cases of up to 35 metric tons per hour.

Capital and operating costs are highly variable and dependent on the application, location and project requirements, says Köpf. “In some scenarios, the RotarEkiin can increase capital costs as much as 10–15%,” he says. “Metso is working to optimize the technology and reduce this impact to assist customers in achieving their decarbonization goals.”

Using microwaves to make ammonia

Ammونيا is becoming more crucial for the energy transition as renewable-power producers look to its potential as a means for energy storage. Typically made using the energy-intensive Haber Bosch (HB) process, solutions for decarbonizing NH_3 typically involve the adoption of carbon-capture systems, or the use of “green” H_2 . Now, a new method for NH_3 synthesis relies on microwaves as its energy source. Developed at the National Energy Technology Laboratory (NETL; www.netl.doe.gov), in partnership with West Virginia University (both Morgantown, W.Va.; www.wvu.edu) and Malachite Technologies (San Francisco, Calif.; www.malachitetech.com), the Microwave Assisted Synthesis (MAS) process uses microwave energy and a patented catalyst to produce NH_3 at much lower temperature and pressure than the HB process. “MAS is a fully electric system that can respond quickly to energy changes. That means it can be paired with renewable power and adjust to the energy input. The HB process

cannot vary production output in this way without losing efficiency,” explains NETL researcher Christina Wildfire.

The microwave energy is applied directly to the catalyst, heating it rapidly and evenly, which enables significantly faster startup times than with large industrial processes. The direct application of energy is also what allows MAS to run at lower temperature and pressure. “The microwaves enhance the chemical reaction and selectively heat the metal sites on the catalyst, providing accelerated electron transfer. The technology will support a very different business model for NH_3 synthesis, going from very large, centralized production to smaller, distributed production closer to the use site, reducing the need for transport,” says Wildfire.

The team has demonstrated MAS at 1-kg/d scale and plans to build a 100-kg/d reactor system and test catalyst durability. Ultimately, Wildfire expects MAS to scale up to around 3-ton/d modules, which would match the typical electrical output of a wind turbine.

(Continues on p. 9)

Commissioning completed for a carbon-capture pilot plant that uses a novel solvent

Commissioning is wrapping up this month for a pilot facility designed to validate the capabilities of a new carbon-capture solvent. The pilot plant was constructed by Koch Modular Process Systems (KMPS; Paramus, N.J.; www.kochmodular.com) as part of Project Enterprise, a U.S. Department of Energy-funded endeavor to capture CO₂ from the flue-gas of Calpine Energy's Los Medanos Energy Center, a natural-gas combined cycle power plant in Pittsburg, Calif. The solvents being tested were developed by ION Clean Energy (Boulder, Colo.; www.ioncleanenergy.com) and are proprietary amine-based solvents designed to improve on the performance and long-term costs of monoethanolamine (MEA), a traditional carbon-capture solvent.

In prior testing at two leading carbon-capture research centers, the ION solvents, called ICE-21 and ICE-31, showed rapid CO₂-absorption kinetics, as well as the ability to capture more CO₂ per unit of volume than MEA. Combined with the

fact that the CO₂-solvent binding energy is lower than MEA's, the solvents require less energy to release the CO₂ and regenerate the solvent.

"There are also important 'soft' benefits over MEA processes," explains ION vice president for engineering Andrew Awtry. "For example, ICE-31 is highly stable under oxidative conditions, so we see less degradation to the solvent over time when used with fluegas from natural gas plants, which contains significant quantities of oxygen." In addition, Awtry says because the ICE-31 doesn't degrade easily, there are very few volatile organic compounds (VOCs) emitted.

ION's plan is to first test MEA at the pilot facility to establish baseline performance and cost, followed by ICE-21 and then ICE-31, which will be run at the pilot facility for one year to validate long-term stability results from previous testing at CO₂-capture research facilities. Once operating with ION's solvents, the pilot plant is expected to have a capacity to capture 10 ton/d of CO₂, Awtry says.

it into the TU Graz network. The maximum storage performance is intended to be at 10 kW.

BIO-BASED ETHYLENE

Braskem S.A. (São Paulo, Brazil; www.braskem.com) has concluded a 30% increase in production capacity of its bio-based ethylene plant, located in the Petrochemical Complex of Triunfo, Rio Grande do Sul, Brazil. The \$87-million investment aims to meet the growing global demand for sustainable products. The plant now operates at an increased capacity, from 200,000 to 260,000 ton/yr. The bio-based ethylene is made from sugarcane-based ethanol.

Each ton of plastic resin made from renewable feedstock represents the removal of 3 tons of CO₂ from the atmosphere. Since the plant's beginning in 2010, more than 1.2 million tons of "I'm green" bio-based polyethylene has been produced. The recent increase in production capacity will remove approximately 185,000 ton/yr of CO₂ equivalent.

(Continues on p. 10)

For details visit adlinks.chemengonline.com/84651-04

Predictable plant-based production of complex biomolecules

Most plant-based bioprocesses involve growing plants in outdoor fields or greenhouses, but this is hindered by local climates and available space, and typical product yields are very low per plant, especially for natural active molecules used in pharmaceutical and healthcare ingredients. Now, a new biomanufacturing platform developed by Samabriva (Amiens, France; www.samabriva.com) takes advantage of the unique properties of hairy roots to create a more stable and predictable way to make high-value molecules.

"We can cultivate hairy roots into a confined environment with only water, sugar and nutrients, and they will continue to grow indefinitely regardless of light or temperature. We can genetically modify the hairy roots in order to overexpress a molecule of interest within the root, meaning we can efficiently produce natural active molecules all year round," explains Marina Guillet, CEO of Samabriva.

Since the hairy roots emerge from a

single cell, they are considered a clonal system, which explains their excellent reproducibility. "This is not a transient system; it is highly stable. Once we have developed the hairy root clone, we are thus always working with the same hairy root clone for many years. Moreover, culture conditions of the hairy root clones can be fully controlled in large-scale bioreactors. This explains why we see such predictable growth rate and productivity of the system over time," adds Guillet.

The company's proprietary bioreactors enable onsite production of high-value molecules for which chemical synthesis is not efficient, such as alkaloids. Samabriva's hairy-root system can also be configured to produce recombinant proteins without the use of any animal cells. The ability to synthesize all of these materials onsite and inexpensively in a GMP-certifiable system is advantageous in that production is not limited by regional growing conditions or transportation costs. ■

FB ENERGY RECOVERY

In late July, Kason Corp. (Chicago, Ill.; www.kason.com) launched the new Vibro-Bed energy recovery system (ERS), an exhaust-air recycling system engineered to help material processors drastically lower energy costs, reduce unpleasant odors and curb emissions. The Vibro-Bed ERS is the latest add-on to Kason's Vibro-Bed fluidized-bed (FB) processor, which is said to be the first and only FB with a circular design for more efficient drying, cooling and moisturizing.

Vibro-Bed ERS can be retrofitted on FB drying systems or added on new installations. A partial-loop drying system, it recycles a portion of the heated air exhausted by the FB, while removing excess water vapor from the air stream. A programmable logic controller (PLC) opens and closes a series of backdraft dampers, forcing the previously heated air back into the FB dryer.

By recirculating heated exhaust air, processors can save up to 50% in energy costs, and payback can be as little as 12 mo, Kason says. □

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Plant Watch

Mitsui Chemicals to increase production capacity for polyurethane dispersions

August 11, 2023 — Mitsui Chemicals, Inc. (Tokyo, Japan; www.mitsuicheicals.com) will increase its production capacity for polyurethane dispersions (PUDs) at the company's Shimizu site. This expansion will approximately double domestic PUD production capacity. Construction is slated to commence in February 2024 and operational launch is expected in June 2025.

Covestro starts up new elastomers plant in Shanghai

August 10, 2023 — Covestro AG (Leverkusen, Germany; www.covestro.com) has started production at its new plant for polyurethane elastomer systems at its integrated site in Shanghai, China. This project is part of a series of investments in Covestro's Elastomers raw-materials business worldwide, including investments in sites in Thailand and Spain.

Indorama completes significant PET recycling expansion in Brazil

August 10, 2023 — Indorama Ventures Ltd. (IVL; Bangkok, Thailand; www.indoramaventures.com) completed the expansion of its recycling facility located in Juiz de Fora, Minas Gerais, Brazil. This project raised production capacity from 9,000 metric tons per year (m.t./yr) to 25,000 m.t./yr of polyethylene terephthalate (PET) made from various post-consumer recycled materials.

Kuraray to expand EVOH production capacities in the U.S. and Europe

August 10, 2023 — Kuraray Co. (Tokyo; www.kuraray.com) plans to increase production of ethylene vinyl alcohol copolymer (EVOH resin) at sites in the U.S. and Europe. A total of 5,000 m.t./yr will be added to U.S. and European bases of operation in 2024, with another 5,000 m.t./yr to be added in 2026. This increase will expand total global production capacity to 113,000 m.t./yr.

Evonik expands rubber silanes production in China

August 9, 2023 — Evonik Industries AG (Essen, Germany; www.evonik.com) started production at a new rubber silanes plant. Operated as a joint venture (JV) between Evonik, DEG and Rizhao Lanxing Chemical Industry Co., the new plant is strategically located in the Rizhao Lanshan Chemical Industrial Park in Shandong Province, China. The expanded plant is specifically designed to meet growing demand within the global tire and rubber industry. With this site, Evonik can now regionally provide product grades previously only available from Evonik's European production sites.

BASF announces capacity expansion for polyisobutenes

August 1, 2023 — BASF SE (Ludwigshafen, Germany; www.basf.com) will increase the production capacity for its medium-molecular-weight polyisobutenes at its site in Ludwigshafen by 25%. The investment comes in response to the rising global demand for medium-molecular-weight polyisobutenes. Applications for such polyisobutenes include surface protective films, window sealants, binder material for batteries and food packaging.

Wacker completes hydrogen chloride capacity expansion at Burghausen site

August 1, 2023 — Wacker Chemie AG (Munich, Germany; www.wacker.com) recently finished significantly expanding its production of ultrapure hydrogen chloride in Burghausen, Germany. Ultrapure hydrogen chloride is used as an etching and cleaning agent for the semiconductor industry. Wacker manufactures hydrogen chloride using rock salt from its own mine in Stetten, Germany.

Mitsui Chemicals breaks ground on new elastomers plant in Singapore

August 1, 2023 — Mitsui Chemicals held the groundbreaking ceremony for a new plant to produce high-performance elastomers in Singapore. The new plant is designed for a production capacity of 120,000 m.t./yr of elastomers, adding to the site's existing capacity of 225,000 m.t./yr. The project is scheduled for completion during 2024.

Sika expands production capacities for macro-fibers at Tennessee plant

July 28, 2023 — Sika AG (Baar, Switzerland; www.sika.com) increased production capacities for macro-fibers at its plant in Chattanooga, Tenn. With this fiber technology, Sika is further strengthening its position in the mining and sustainable construction sectors. Synthetic macro-fibers are the basis of a technology for the reinforcement of concrete construction, significantly enhancing the properties of cured concrete and surpassing traditional steel reinforcement, the company says.

Mergers & Acquisitions

Origin Materials and Proman to partner on low-carbon biofuels production

Origin Materials, Inc. (West Sacramento, Calif.; www.originmaterials.com) and methanol producer Proman (Wollerau, Switzerland; www.proman.org) announced a strategic partnership centered on low-carbon biofuel production. Origin expects to produce biofuels using its patented technology platform, which turns the carbon found in wood residues into useful products.



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Cummins and Chevron advance low-carbon fuels collaboration

August 11, 2023 — Cummins Inc. (Columbus, Ind.; www.cummins.com) and Chevron U.S.A. Inc. (San Ramon, Calif.; www.chevron.com) announced a memorandum of understanding related to low-carbon-fuel value chains. The announcement expands their previous strategic collaboration on hydrogen and renewable natural gas and is expected to encompass other liquid renewable fuels, such as renewable gasoline blends, biodiesel and renewable diesel.

Ineos and Sinopec complete formation of petrochemicals JV

August 9, 2023 — Ineos Ltd. (London, U.K.; www.ineos.com) completed the formation of a 50/50 JV with Sinopec Group (Beijing, China; www.sinopec.com) for the Tianjin Nangang Ethylene Project, which is currently under construction and expected to be onstream by April 2024. The complex includes a 1.2-million-m.t./yr cracker, a new 500,000-m.t./yr high-density PE plant and 11 other derivative units.

Conagen and Sumitomo Chemical jointly develop new biopolymers

August 1, 2023 — Conagen (Bedford, Mass.; www.conagen.com) and Sumitomo Chemical Co. (Tokyo, Japan; www.sumitomo-chem.co.jp) plan to jointly develop *p*-hydroxystyrene (HS) and poly *p*-hydroxystyrene (PHS), using an advanced combination of biosynthesis, chemosynthesis and polymerization. The monomer HS can be used as an input for the synthesis of other substances, such as pharmaceuticals and fragrances.

BASF and Huntsman to separate joint MDI production in China

July 31, 2023 — BASF and Huntsman Corp. (The Woodlands, Tex.; www.huntsman.com), together with their Chinese partner companies — Shanghai Hua Yi Group, Sinopec Shanghai Gaoqiao Petrochemical Co. and Shanghai Chlor-Alkali Chemical Co. — announced the planned separation of their joint diphenylmethane diisocyanate (MDI) production at Shanghai Lianheng Isocyanate Co. (SLIC). Going forward, the companies will operate the two MDI

plants located at the site in Caojing, China, independently.

KBR and Air Liquide to collaborate on low-carbon ammonia

July 19, 2023 — KBR, Inc. (Houston; www.kbr.com) and Air Liquide S.A. (Paris, France; www.airliquide.com) have aligned to expand the application of mega-scale production technologies for low-carbon ammonia. This partnership will add autothermal reforming (ATR) technology to KBR's existing ammonia processes.

LanzaTech and Gail partnering on CO₂ capture pilot in India

July 19, 2023 — LanzaTech Global, Inc., (Skokie, Ill.; www.lanzatech.com) and GAIL Ltd. (New Delhi, India; www.gailonline.com), India's largest natural gas company, will explore setting up a pilot-scale CO₂ capture and conversion project. The project will enable resource utilization, whereby the building blocks of common consumer goods can be made from biorecycled materials instead of fossil fuel.

Mary Page Bailey

The Changing Face of Water Treatment

Modern solutions help processors achieve water-related goals in a more proactive, cost-effective way

Although water reuse and recycling began as a necessity in regions where water scarcity was a significant challenge, the increasing cost of water coupled with aggressive sustainability goals has transformed water reuse/recycling and related treatments into an integral component of almost every chemical process around the world. Meanwhile, because water treatment is not a one-size-fits-all practice, a tailored combination of updated solutions can help today's processors achieve their water-related goals in a more cost-effective, proactive and sustainable way.

"There historically has been a significant interest in water recycling/reuse in 'water-challenged' regions and areas where domestic water needs have increased, which reduced the availability of water for industry," says Walter Kozlowski, senior director of client sustainability solutions with Evoqua Water Technologies, now part of Xylem (Pittsburgh, Pa.; www.evoqua.com). "However, interest in recycling and reusing water now extends to regions that typically do

not have significant water-availability struggles due to increased emphasis on sustainability goals in which all of an organization's facilities need to reduce their water footprint and contribute to the broader goal. Also, water costs are rising in all regions, so recycle and reuse solutions are becoming much more economically feasible" (Figure 1).

However, because many of the water-treatment practices employed years ago are no longer the best fit for current water-treatment needs, processors and water-treatment experts have begun to explore new and often customized approaches to achieve today's water goals, says Pete Macios, director of research with Veolia Water Technologies & Solutions (Trevose, Pa.; www.watertechnologies.com). "As the economic, environmental and regulatory climates change — for example, phosphates, a common water treatment chemistry of the past, are now banned in many countries — we are looking at alternative treatments and chemistries, as well as combined approaches and solutions,"

says Macios. "I'm confident in saying that the treatments and chemistries of 10 years ago don't meet current needs, so if you haven't changed your water-treatment methods in the past decade, it's likely time for an update using modern alternatives."

Roi Zaken Porat, director of water-treatment process at IDE Technologies (Kadima, Israel; www.ide-tech.com), agrees that there is an industry-wide trend toward more sustainable water practices, including zero liquid discharge (ZLD), minimal liquid discharge (MLD), water reuse and recycling and water planning, in an effort to improve water efficiency, reduce environmental impact, meet new regulations and enhance resource utilization. He adds that the newest approach to achieving sustainable water practices relies on the use of a customized combination of modern technologies, including treatments such as advanced filtration and separation (such as reverse osmosis (RO) and membranes), biological treatment processes for wastewater and reuse, evaporation and crystallization technologies and advanced water monitoring and analytics systems for efficient water management. But he adds that the way in which these and other technologies fit together differs for every application.

Not one-size-fits all

"The chemical process industries (CPI) comprise many different segments, product categories and needs, ranging from basic building blocks like ethylene to complex specialty materials for various industrial end-user applications. This requires each water-treatment application to be tailored to meet



FIGURE 1. Shown here is an Evoqua brine-recovery reverse-osmosis (RO) system installed as part of a water reuse program



FIGURE 2. DuPont's MLD solution, along with the company's DesalTec Closed Circuit Reverse Osmosis (CCRO) technology, helped a chemical processor achieve minimal liquid discharge while also recovering valuable, high-quality salts that they were able to reuse in their operations

the specific requirements of each water-treatment application, as well as the requirements of the particular process," says Juvencio Casanova, director of customer vertical with Evoqua. "While there are common solutions, such as pre-treatment, demineralization and polishing at the front end and meeting wastewater compliance at the tail end, challenges can arise based on location and the type of source water used. Additionally, a variety of challenges regarding product water quality specifications, such as the need to meet ultrapure water specifications or the necessity for high reliability due to water being an essential component of the chemical processor's outputs, such as in hydrogen production, can play a role in the selected treatment methods."

In addition, economic feasibility and sustainability also play roles in selecting a water-treatment program. For example, while many facilities had an interest in ZLD, it was often difficult to justify financially, so minimal liquid discharge (MLD) is becoming a more viable alternative for many facilities. But the way either ZLD or MLD is achieved can differ, depending on the specific water quality and processes at a particular facility. Often it is a customized solution including a combination of technologies such as membrane filtration, media/ion-exchange technologies, ultraviolet (UV) light solutions, ozone treatment and many other choices. "Facilities should employ technologies that are the best fit for that application based on both

the cost and performance," says Evoqua's Kozlowski.

Veronica Garcia Molina, global marketing manager for industrial and energy segments with DuPont Water Solutions (Wilmington, Del.; www.dupont.com/water), agrees and adds that many of today's approaches are also targeted at adding

value to the organization: "The cost of ZLD can greatly impact the ability to meet production goals and, because ZLD is such an energy-intensive process, it's not necessarily the most environmentally friendly practice, which is driving facilities to explore alternatives, such as an MLD process combined with emerging solutions that can do more than treat the water — they may also provide value or savings."

She points to one customer, a coal chemical company in China that struggled to expand their production capacity while trying to obtain ZLD. "Instead, an MLD solution, along with our new DesalTec Closed Circuit Reverse Osmosis (CCRO; Figure 2) technology, tackled the tough-to-treat water challenges, including wastewater that contained high salt content, high suspended solids and a variety of organic pollutants. Our customer was not only able to meet water requirements as a result of the MLD solution, but they were also able to recover valuable, high-quality salts that they were able to reuse in their operations — providing additional savings."

In a similar vein, IDE offers the MaxH₂O Desalter System (Figure 3), which uses an RO system and a fluidized-bed reactor to allow significant water recoveries while crystallizing out non-soluble salts from the system, presenting a lower cost and smaller footprint compared to alternative technologies. MaxH₂O operates with variable feed-water qualities, concentrations, flows and recoveries. It can be integrated as a standalone solution or as a down-

stream solution to reduce total dissolved solids, reduce brine volumes and produce high-quality permeate for process reuse, solving the existing challenges of extremely stringent sulfate discharge regulations, challenging water compositions, low water recovery and high operational costs.

Additional options and various combinations exist for nearly every water treatment situation, says DuPont's Garcia Molina. "Multi-tech solutions can be tailored to address a range of water treatment applications and situations. For example, we can provide high-recovery schemes for sites with limited water with CCRO, minimize plant downtime caused by biofouling, provide solutions with minimum or no chemical usage using UF, RO, mechanical CO₂ and O₂ removal and we can help mitigate inlet water quality fluctuations with a combination of resins."

"A lot of factors play into which technology or technologies will be most suitable for an application," says Veolia's Macios. "Not only are there new chemistries and treatment options available, but there are more sustainability goals for water and greenhouse gases, more challenges associated with stressed water sources and processors still obviously must operate and achieve the desired output from the plant. The key in selecting a treatment is to find the one that allows processors to achieve all their goals — water, sustainability and operational — in a way that optimizes the chemical process, provides value and makes financial and environmental sense for their specific situation."

Reducing carbon footprint, too

Since many processors are re-vamping their water-treatment programs as part of all-inclusive sustainability agendas, many are looking for "greener" water-related solutions that will help them achieve sustainability goals by reducing their electricity use and carbon footprint, while still meeting their water-treatment needs in a cost-effective manner.

"Non-chemical devices are popping up in an effort to eliminate chemistry from water treatment," says



FIGURE 3. IDE offers the MaxH₂O Desalter System which uses an RO system and a fluidized-bed reactor to allow significant water recoveries while crystallizing out non-soluble salts from the system

Mike Mowbray, senior vice president of marketing and technology with Kurita America (Minneapolis, Minn.; www.kuritaamerica.com). “And while they do work in narrow applications, they don’t have broad spectrum of application the way that chemistry does, so we are working on solutions that minimize the amount of chemistry that we use or that use a more acceptable chemistry, such as one that is biodegradable and can be discharged, as well as other options that help support sustainability along with water treatment.”

One such example is Kurita’s Dropwise Condensation Technology (Figure 4), a film-forming solution that is sprayed into critical heat exchangers and vessels and reduces the thin water layer that builds up inside a steam vessel. “That thin water layer becomes an insulating barrier and requires more energy to get heat from steam through the heat exchanger to the process on the other side,” Mowbray explains. “The Dropwise solution increases the water repellency and changes it from water film condensation to liquid droplets condensation, increasing heat transfer efficiency. We see a 5% increase in energy efficiency, which reduces the amount of energy used in the process and has an impact on a facility’s overall CO₂ footprint. This savings can add up in facilities that have large heat exchangers and vessels.”

Another way processors can increase their sustainability and reduce their carbon footprint while still achieving water treatment and production goals is through the use

of biosurfactants. As biosurfactants are produced from microbes, they provide advantages, such as biodegradability, lower toxicity and environmental compatibility. In addition, the application of biosurfactants is growing in wastewater treatment due to their foaming ability, specific activity and high selectivity under wide operational windows of temperature, pH and salinity. They are also gaining traction in water treatment because they can have lower cost in use and are environmentally friendly.

“Biosurfactants help reduce the carbon that comes from using naturally based materials,” says Tim Kraemer, director of global business with Locus Ingredients (Solon, Ohio; www.locusingredients.com), a producer of biosurfactants (Figure 5) that has entered into a collaboration with Veolia Water Technologies to develop new sustainable, bio-based water and process additive treatments, such as emulsion breakers in boiler treatments and cooling water programs. “Taking it a step further, our products are multifunctional,” says Kraemer. “While they offer several features that allow for the replacement of chemicals that would be performing one function within the formulation, in

many cases, biosurfactants can replace at least two chemicals in a water-treatment program. This means processors are not only consolidating formulations, but also are replacing traditional petrochemical materials that have a higher carbon footprint impact with one that is lower.”

Veolia’s Macios explains further: “On the application side, what we see with some biomaterials is not just surfactant properties, but also corrosion-inhibiting properties in both water treatment and process water treatment. We see lots of advantages in the ability to replace not just one for another, but in how one material can often replace at least two more harmful materials. This will help advance the sustainability profile and environmental impact of water treatment, while optimizing performance and reducing costs.”

Veolia’s Macios explains further: “On the application side, what we see with some biomaterials is not just surfactant properties, but also corrosion-inhibiting properties in both water treatment and process water treatment. We see lots of advantages in the ability to replace not just one for another, but in how one material can often replace at least two more harmful materials. This will help advance the sustainability profile and environmental impact of water treatment, while optimizing performance and reducing costs.”

Benefits of digital technologies

Just as a variety of solutions and more sustainable offerings are allowing processors to meet water-related goals, digital technologies and increased connectivity are helping processors more easily achieve a reduction in their water footprint. “These technologies allow facilities to better understand where and how they are using water, which results in better decision-making regarding water reuse/recycling and treatment,” says Evoqua’s Kozlowski. “These technologies can also improve operations by proactively alerting processors to changes in conditions and allowing water treatment systems to adapt more quickly. Further, predictive analytics can greatly reduce op-

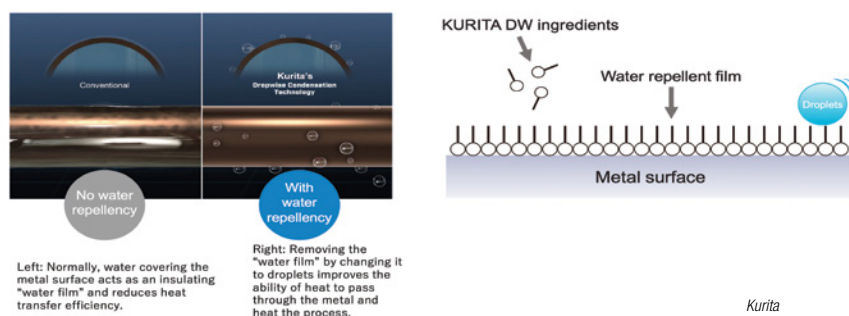


FIGURE 4. Kurita’s Dropwise Condensation Technology, a film-forming solution that is sprayed into critical heat exchangers and vessels, reduces the thin water layer that builds up inside a steam vessel, which increases water repellency and changes it from water film condensation to liquid droplets condensation, increasing heat transfer efficiency and reducing the amount of energy used in the process



FIGURE 5. Processors can increase their sustainability and reduce their carbon footprint while still achieving water-treatment and production goals with biosurfactants

erational costs as systems operate per the conditions needed, rather than operating at a set level all the time.”

Veolia’s Macios agrees that the use of digital technologies for water monitoring is providing a lot of benefits for chemical processors, especially those with distressed or variable feeds. “There’s a real challenge to treating distressed water, which is frequently the case

due to the increase in water reuse and recycling,” he says. “The water source can change from day to day or hour to hour and processors want the ability to observe what’s happening in their assets so that they may react appropriately by pulling back on treatment when possible or treating more aggressively when needed.”

Taking it a step further, says Evoqua’s Kozlowski, is the addition of technologies such as machine learning, which can be used to more effectively provide alerts to potential or active maintenance issues, allowing for faster repair or adjustment before there is a significant impact to operations. And, according to Kurita’s Wombray, digital twins can be used to replicate an entire process so that chemical processors may try different water-related variables to see what impact they will have on the process and sustainability efforts before making changes to the live process.

“These types of digital technologies, wireless solutions and Industry 4.0 principles, including water monitoring and analytics, as well as smart water management practices, are increasingly prevalent,” says IDE’s Porat. “These technologies provide real-time data, remote monitoring capabilities, predictive maintenance and optimization of water treatment processes, resulting in improved operational efficiency, reduced costs and enhanced overall performance.”

“Most processors are trying to embrace sustainability in all aspects of their business,” says Kurita’s Mowbray. “And there’s a lot of new, updated water treatment technologies that can help them lower water use and freshwater use, reduce greenhouse gas emissions and lower energy use overall, but the key is coming up with a customized solution that works for their individual water treatment needs, sustainability goals and budget. What works for one facility may not provide value for another.”

Joy LePree

Focus on Motors and Drives



Flender International

On-point configuration for all requirements

With the new Flender One platform, this company's engineers have developed the world's narrowest gear-ratio range, with 103 stages between 1 and 7.1 per size for applications that require particularly precise speed, such as pumps and paper machines. This allows the rotational speed to be set almost ideally for maximum efficiency in these applications. The new platform not only optimizes efficiency during planning, but also during operation. The optimized Metaperform gearing reduces power loss by up to 50% compared with previous gear unit solutions. The digital enabler of all measurements and optimizations is the company's new gearbox intelligence AIQ (photo). Its sensor technology and analysis functions continuously measure the torque and detect whether the gearbox and the plant are driven in overload or underload. The sensor not only records operating states, but also processes them directly, interprets them and provides operators with recommendations for action. — *Flender International GmbH, Bocholt, Germany*
www.flender.com



Force Control Industries

These clutch brakes fit in tight quarters

Posidyne clutch brakes (photo) can be ordered with special pads cast into the main housings to mount an adjustable motor base, allowing the motor to sit atop the clutch brake in a space-saving "piggyback" design. This arrangement also includes a gear belt drive from the motor to the input shaft and an enclosed belt drive guard. The Posidyne features oil shear technology that allows rapid and precise stopping, starting, speed change and positioning, all without adjustment or maintenance. Posidyne piggyback clutch brakes are well suited for applications with frequent start/stop cycles, and high cycle rates (up to 300 cycles per minute). Posidyne clutch/brakes feature a multiple disc design that produces high torque from a small package. Recirculating the fluid dissipates the heat of engagement, which is a common cause of downtime with

other clutch/brake assemblies. Multiple sizes are available to suit applications from 0.5 to 350 hp. — *Force Control Industries, Inc., Fairfield, Ohio*
www.forcecontrol.com

Improve energy efficiency with these regenerative drives

This company has introduced a new range of compact regenerative drives. The range includes three options; the U1000 Low Harmonics Regenerative Matrix Converter, the D1000 Regenerative Converter Unit and the R1000 Regenerative Unit. The U1000 (photo) is designed to exceed the performance of general-purpose a.c. drives, exceeding the IEEE 519 harmonic guideline for power quality, and suitable for single-motor drive applications, such as powering lifts, escalators, HVAC machinery, hoists, centrifuges and others. The drive does not require any braking resistor, which typically wastes any regenerative energy into heat. This means the regenerative energy can be utilized by other consumers in the same grid, saving total energy cost and consumption, while also reducing the panel cooling system requirements. — *Yaskawa UK Ltd., Newton Aycliffe, Durham, U.K.*
www.yaskawa.co.uk



yaskawa UK

These VFDs provide flexible motor control, energy savings

A new line of VF1A Doesa variable frequency drives (VFDs; photo) offer versatile control and efficient operation of electrical motors for a wide range of applications. VF1A Doesa VFDs are suitable for speed control of variable- and constant-torque applications, ranging from fans and pumps to specialized equipment. The VFD is capable of driving an induction motor (IM) or a permanent-magnet synchronous motor (PMSM). IMs can be driven in open loop or closed loop, while PMSMs can be driven in open loop only. The product family features a compact form factor in a UL open-type construction, with nickel- and tin-plated bus bars and conformal coatings for corrosion protection. The VFD is designed for a



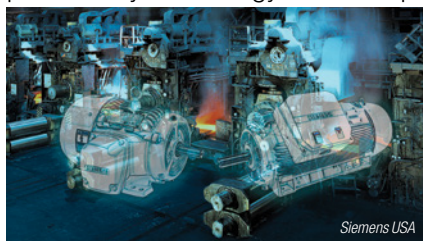
IDEC

long operating life, and provides a maintenance alarm signal. Electrical input is nominally rated as three-phase, low-voltage a.c. 400 V (with an allowable input voltage range of 380–480 V a.c.), and the VFDs come in 14 models with a capacity range of up to 139 A. Each VFD is quadruple rated for varying duties — normal or heavy overload, and mild (40°C) or high (50°C) temperatures — so users can minimize the number of models needed to handle a wide range of applications. Other functionality includes control of mechanical brakes, a built-in braking transistor, regeneration avoidance and low-voltage ride through. Safe torque off (STO) capability ensures the VFD fulfills functional safety standard requirements while eliminating the need for external circuit breakers required by conventional VFDs. — *IDEC Corp., Sunnyvale, Calif.*

www.idec.com/usa

Severe-duty a.c. motors with 75–800-hp output

The Simotics SD200 severe-duty motor in frame size 440 (photo) provides high productivity and energy-efficient operation in all torque ranges. These new cast-iron NEMA motors are built to power pumps, fans, compressors, hoists, winders and similar equipment in harsh environ-



ments. With a three-year warranty, the SD200 motors offer 75–800-hp output and feature 444–5013 cast-iron frames for operation in 460 and 575 V ranges. They meet or exceed NEMA Premium MG1 Table 12-12 efficiencies. A wide selection of options is offered, including IP56 ingress protection, encoders, brakes and blowers, plus others to suit the applications presented. On these motors, the frame, end-shields, fan guard and easy-access, diagonally split, oversized terminal box are all cast-iron. Complementing this construction are zinc-plated hardware, epoxy paint and stainless-steel nameplates for long life and easy identification in the field. A unique offset rotor bar provides improved efficiency, while larger bars and end rings reduce resistance. Each die-cast aluminum rotor assembly is dynamically balanced for extended bearing life and includes a high-strength C1045 carbon-steel shaft for maximum performance. — *Siemens USA, St. Paul, Minn.*

<http://usa.siemens.com>

Silver Sustainability Certificate for this company

This company was assessed by the global sustainability rating agency EcoVadis in 2022 and awarded the silver sustainability certificate (photo, p. 20). The company received 65 out of 100 points, placing them in the 89th percentile rank and significantly higher than the average ratings scored by other companies in the industry. The company's latest innovations include the highly efficient IE5+ product line, consisting of the DuoDrive integrated gear unit and motor, IE5+ synchronous motors, and Nordac ON/ON+ variable-frequency drives. This series not only offers high efficiencies, but also works to reduce the number of system variants and total cost of ownership. — *Getriebebau Nord GmbH & Co. KG, Bargteheide, Germany*

www.nord.com

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Getriebeheide Nord



ABB Motors

Water-cooled motors deliver high efficiency

Available with induction, synchronous reluctance (SynRM) or permanent magnet rotor technology, these water-cooled motors can achieve high-efficiency (IE3-IE5) ratings for energy savings, and the power-dense designs deliver more power in a smaller footprint than similarly sized totally enclosed, fan-cooled motors. The HydroCool XT (photo) is available in four NEMA frame sizes and ratings from 60 to 1,250 hp. The M3LP has IEC frame sizes 280–500 with ratings from 120 to 2,700 hp. Cooling efficiency is maintained even at low speeds, allowing for direct-online or variable-speed operation without derating or power loss. The water-cooled motors are equipped with provisions for the company's Ability Smart Sensor condition monitoring for instant motor health and performance information, providing connectivity and data analytics to make operations efficient, predictable and safe. — *ABB Motors and Mechanical, Inc., Fort Smith, Ark.*

www.us.abb.com

High-voltage servo motors for hazardous locations

For hazardous locations that require use of an explosion-proof motor, the Goldline EB series of ATEX-certified and IECEx/cETLus-listed servo motors now includes the 480 V a.c. Goldline EBH. Explosion-proof motors are required in hazardous locations where flammable gases, mists or vapors may exist in explosive or ignitable concentrations. Such environments are often found in mines, oil-and-gas refineries, textile mills and industrial paint booths. For high-voltage applications in hazardous locations, Goldline EBH servo motors offer speeds up to 7,500 rpm with exceptionally high torque density for maximum performance in a minimal installation footprint. Rugged resolver feedback and a built-in thermostat support reliable operation under harsh environmental conditions. — *Kollmorgen, a Regal Rexnord brand, Radford, Va.*

www.kollmorgen.com

Gerald Ondrey

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Each Dynamic Air system is custom

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For details visit adlinks.chemengonline.com/84651-10

Plant Cybersecurity Awareness

Department Editor: Scott Jenkins

The expanding use of digitalization tools at chemical process industries (CPI) facilities, coupled with the ongoing convergence of operational technology (OT) systems with traditional computer information technology (IT) systems, has increased plant cybersecurity risks. All plant personnel play a role in preventing negative impacts from cyberattacks. This one-page reference* aims to increase cybersecurity awareness among those without day-to-day cyberdefense roles.

Primary cyberthreat actors

CPI facilities should be concerned primarily with cybersecurity threats from three groups.

- **Cybercriminals:** These individuals or groups aim to exploit vulnerabilities for financial gain, often through ransomware attacks or theft of intellectual property
- **Hacktivists:** Hacktivists pursue ideological or political motives and may attempt to disrupt operations or damage an organization's reputation to further their cause
- **Nation-state actors:** State-sponsored hackers may engage in cyber-espionage, sabotage or disruptive attacks targeting critical infrastructure for strategic and political purposes

Common cyberattack types

The following summarizes common classes of cyberattacks:

- **Spear-phishing:** Targeted phishing emails aimed at specific individuals or departments to trick them into revealing sensitive information or clicking on malicious links
- **Ransomware:** Malware that encrypts a victim's data, making it inaccessible until a ransom is paid to the attackers
- **Distributed denial of service (DDoS):** Overwhelming a target system or network with a flood of traffic to disrupt its normal operation
- **Insider threats:** Malicious actions or unintentional mistakes by employees or contractors that compromise the organization's security

- **Man-in-the-middle (MITM) attacks:** Intercepting and altering communications between two parties to gain unauthorized access or manipulate information
- **Zero-day exploits:** Exploiting undisclosed vulnerabilities in software before a patch is available
- **Supply-chain attacks:** Targeting vulnerabilities in a company's supply chain to gain access to the organization's systems

Cyberdefense strategies

CPI facilities can follow these cyberdefense strategies to enhance their cybersecurity posture:

- **Risk assessment:** Perform regular risk assessments to identify vulnerabilities, threats and critical assets to prioritize security efforts effectively
- **Security training:** Provide comprehensive cybersecurity training to all personnel to raise awareness and build a security-conscious culture
- **Network segmentation:** Implement proper network segmentation to limit the lateral movement of attackers within the network and contain potential breaches
- **Patch management:** Maintain a robust patch-management process to address known vulnerabilities promptly
- **Access control:** Enforce strict access controls, including strong authentication mechanisms, to limit sensitive systems and data access
- **Incident response plan:** Develop and practice a well-defined incident response plan to respond swiftly and effectively to cyber-incidents
- **Continuous monitoring:** Implement continuous monitoring solutions to detect anomalies and potential threats in real time

Lessons from previous attacks

The following are key lessons learned from previous cyberattack incidents:

- **Proactive planning:** Proactively developing and regularly testing incident response plans is crucial for minimizing cyberattacks' impact
- **Employee training:** Well-informed and trained employees are a critical

line of defense against social engineering attacks and can help detect threats early

- **Vendor management:** Engaging with vendors prioritizing cybersecurity and providing regular updates and patches is essential to reducing third-party risks
- **Regular assessments:** Conducting regular security assessments and penetration testing can help identify weaknesses and improve overall resilience
- **Information sharing:** Collaborating with industry peers and information-sharing forums can help plant personnel stay informed about emerging threats and effective defense strategies

Cyber-incident response

Robust cyber-incident response plans should include the following elements:

- **Preparedness:** Proactive planning and risk assessments help to identify potential cybersecurity threats and vulnerabilities
- **Detection:** Continuous monitoring and early detection of security incidents will minimize their impact
- **Containment:** Isolate and contain the incident to prevent further spread and damage
- **Eradication:** Identify and eliminate the incident's root cause to prevent reoccurrence
- **Recovery:** Restore affected systems and data to normal operation safely
- **Communication:** Clear and timely communication with stakeholders, including employees, customers, and regulatory authorities
- **Lessons learned:** Conduct a thorough post-incident analysis to identify areas for improvement and update response plans accordingly
- **Legal and regulatory compliance:** Ensure compliance with relevant laws and regulations, reporting incidents when required

***Editor's note:** The information for this column was provided by Charlie Souza, the functional safety and industrial control system cybersecurity lead at AcuTech Consulting Group (Tysons Corner, Va.; www.acutech-consulting.com), and board member at the Chemical and Petroleum Industries Division of the International Society of Automation (Research Triangle Park, N.C.; www.isa.org).

Optimizing Fluidized-Bed Drying Processes

Modern control technologies and industrial automation strategies can help processors use fluidized-bed dryers to drive competitiveness and profitability

Alan Messenger
Optimal Industrial
Automation

IN BRIEF

WHY FLUIDIZED-BED
DRYING?

A CLOSER LOOK AT
FLUIDIZED-BED DRYING

ENHANCING DRYER
CAPABILITIES

UPGRADING CONTROL
SYSTEMS

SKILLED AUTOMATION
SPECIALISTS

CASE STUDY EXAMPLES

CONCLUDING REMARKS

The ability of fluidized-bed dryers to achieve exceptional performance and deliver high-quality results in the controlled, gentle and homogeneous drying of wet solids is unparalleled. This is why these units have long been integral to operations in the pharmaceutical, chemical and food-and-beverage industries. To benefit from optimal fluidized-bed drying operations, companies need to keep up with the evolution of control technologies and industrial automation. In so doing, companies can stay ahead of the game, delivering high-quality products with short lead times and costs.

Why fluidized-bed drying?

Among the most common equipment classes in a variety of manufacturing industries, dryers are fundamental in the processing of goods. Reducing the water content of a bulk solid material slows the growth of microorganisms and insects, suppresses undesirable reactions that can deteriorate the material, and also decreases its weight. Drying therefore improves the shelf life, storability and transportability of products.

A variety of drying methods are available to support highly diverse processes and needs. One such method is fluidized-bed drying, which relies on feedstock fluidization, whereby a high-pressure, hot air stream passes vertically through a perforated plate into the bed of solid particles in the feedstock bed. As the hot air passes through the container, granules are suspended in the rising air and begin to dry. The solid bed is therefore converted into a boiling liquid, and said to reach a fluidized state. The continuously moving mass of particles, in constant contact with the gas stream, which takes away the moisture as vaporized liquid, results in highly efficient drying. The gas, as well as any solvent from the feedstock, passes through a filtered outlet and can then be recycled for reuse.

Given the nature of this process, fluidized-bed drying is extremely common when handling powders or granules in chemical, agrochemical, ceramic and pharmaceutical manufacturing as well as food-and-beverage processing. In practice, this hot-air-driven solution is a mainstay in granulation operations for oral solid dosage (OSD) pharmaceutical production, as it offers a highly effective framework to form strong bonds for the agglomeration of powder formulations. As a result, it is possible to obtain perfectly compressed products, such as tablets and caplets.

A closer look at fluidized-bed drying

Methods that use hot air in this fashion are extremely valuable because high-quality setups offer high drying rates, contributing to optimal throughput, short cycle times, thermodynamic efficiency and uniform moisture reduction while minimizing the potential for mechanical damage to the products. Moreover, these units typically feature a long service life, due to the absence of any moving parts. This requires limited investment for maintenance and repairs and minimal downtime (Figure 1).

While fluidized-bed dryer hardware can run for many years — many units installed over 35 years ago are still operating — the control system that regulates the process should be updated regularly. Regular updates can help manufacturers improve the time-, cost- and



FIGURE 1. Fluidized-bed dryer hardware, like the equipment shown here, can run for many years, but plants should consider updating the control system regularly



FIGURE 2. Smarter setups for fluidized-bed drying control, such as this example for a pharmaceutical product, offer greater capabilities, enabling greater consistency and high quality, while improving energy usage, production times and equipment service life

energy-efficiency of their drying and granulation activities, while improving end-product quality and consistency.

For example, early fluidized-bed solutions relied on simple, set operating functions, such as fixed batch times and inlet air conditions. These situations cannot accommodate feedstock variability and can therefore lead to under- or overdrying, as well as particle overheating — all of which affect product quality and value. More precisely, if the granules are overdried, the resulting materials may be prone to fracture, while insufficient drying can cause bed stalling, poor flow or product stability issues. If specifications are not met, the disposal or rework of entire batches may be needed, increasing production time and raising cost.

In addition to compromising end-product quality and its potential market value, sub-optimal drying can also considerably slow down manufacturing times, since hot materials may require longer cooling periods. Furthermore, if the air flowrate is too low, the material will never reach a fluidized state. If air flowrate is too high, a large volume of particles can escape from the drying environment along with the hot air, ending up in the filters. This not only results in unwanted product loss but can also cause a blockage in the outer filter, increasing the pressure in the vessel and damaging the equipment.

Finally, suboptimal processing conditions can overuse energy, leading to more expensive and less sustainable operations.

Enhancing dryer capabilities

To remain competitive, especially in the digital era, end users may be interested in replacing traditional control systems with more recent setups, which are generally smarter, offering greater power over the regulation of fluidizing and drying processes. Consequently, companies can deliver products of consistent and high quality while improving energy usage, production times and equipment service life.

Inline and online sensors and other analyzers can measure a variety of parameters in real time. These include temperature, pressure, product moisture content, air humidity, air flowrate and velocity at the inlet and outlet, solvent concentration in the exhaust gas, as well as encoder feedback to monitor the speed of fan motors. Modern devices can then share relevant data to a controller (Figure 2), such as a programmable logic controller (PLC), and a supervisory control and data acquisition (SCADA) system for automated feedback or feedforward control (or both) to support responsive operations, which can adapt to the specific feedstock being processed, as well to as the stage of

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FIGURE 3. Controllers for fluidized-bed dryers can connect to more inline and online sensors, so there is comprehensive information available to optimize fluidized-bed dryers

the drying operation.

Even in setups that already feature data-driven devices, it is important for companies to keep up with the latest technologies. First, this helps avoid downtime associated with the unexpected failure of legacy equipment, which may be challenging to replace. Reverse-engineering obsolete automation devices that are broken can be complex and time-consuming — an unwelcome obstacle when time is of the essence for restoring production.

In addition to ensuring reliability and uptime, choosing to upgrade key components can help enhance drying operations, in terms of accuracy and performance, while simplifying the entire control system, and simplifying future maintenance and repairs. For example, earlier PLCs offered limited functions, whereas more recent solutions feature many pre-coded functions. This reduces programming requirements and makes better use of central processing unit (CPU) power while improving code readability.

The latest controllers can also connect to more inline and online analyzers, through enhanced interoperability, CPU performance and data-processing speed. As a result, users are able to collect more information on additional process parameters and product quality attributes (Figure 3). This offers benefits in the form of comprehensive actionable insights to optimize fluidized-bed drying operations and output on the fly. In particular, it is possible to create ever more accurate, multivariate predictive models for process and quality control based on process

tions. Within these applications, the components of a fluidized-bed dryer can communicate with other machines on the shop floor, as well as enterprise-level systems, to improve flexibility, productivity and efficiency. Furthermore, automated data storage and sharing can be implemented to maximize visibility and accessibility for regulatory bodies, in line with current good manufacturing practice (cGMP). This, in turn, facilitates quality audits that ensure compliance with relevant legislation.

Upgrading control systems

Given the prominent role that control systems have in fluidized-bed dryer performance, as well as in product quality, their upgrade should be optimized to the application at hand. Therefore, end users should consider a number of aspects to add value to their existing setups.

When the equipment is used within highly regulated industries, such as pharmaceutical manufacturing, it is recommended to minimize any interventions, in order to streamline re-validation requirements. Following this guideline can be helpful for companies in other industries too, because it can limit capital expenditure while getting the most out of the existing components and reducing

analytical technology (PAT) frameworks.

Ultimately, the upgrade to more advanced control setups can support the digitalization of businesses and the implementation of future-oriented industrial internet of things (IIoT) applica-

equipment waste.

Minimizing changes to the system also means favoring products from the same vendors as the existing pieces, unless they are no longer available. This specification can help ensure compatibility with the remaining components, while simplifying programming-related activities. In particular, it can support the effective reverse engineering of the control framework, which may be necessary when technical documentation on the system is incomplete or missing.

Finally, safety is of the utmost importance and any modification to fluidized-bed dryers should ensure that any operational risks are minimized. More advanced control systems can help enhance accident-prevention strategies, ultimately reducing unexpected downtime and costs, while lengthening the useful life of fluidized-bed dryers. For example, accurate and reproducible outlet-air flow measurements can help identify and alert users to any blockage, which could cause the unit to overheat and lead to components melting or being otherwise damaged, as well as fires or explosions. Similarly, choosing modern PLCs with state-of-the-art protective functions that can meet the necessary safety integrity level (SIL) rating can help manufacturers reduce risks.

Skilled automation specialists

With many aspects to consider when upgrading the control system of a fluidized-bed dryer, manufacturers and processors should partner with an expert industrial automation specialist and system integrator. This collaboration can guide



FIGURE 4. A PLC-driven system allows users to monitor feedstock throughout the process



FIGURE 5. By leveraging process analytical technologies, moisture could be monitored in real time using near infrared spectroscopy

companies in identifying the most effective strategies to improve the performance of this equipment, maximizing the end results.

Moreover, a knowledgeable professional that is up to date with the latest advances in technology and has expertise in interacting with multi-vendor devices is an asset. Such a specialist can identify the components that are best suited to address the specific needs and requirements of the existing setup, as well as program them. Reverse-engineering, establishing compatibility and interoperability are also supported through such a partnership.

Finally, by establishing a long-lasting cooperation with a full-service provider of automation solutions, end users can take advantage of reliable after-sales assistance. This can drive the continuous improvement of their fluidized-bed dryers, as well as deliver a quick turnaround when maintenance or repairs are needed.

Case study examples

The following are real-world examples showing the impact of control-system improvements on fluidized-bed drying operations.

Case study 1: Productivity boost through customized upgrade of control system. A major blue-chip pharmaceutical manufacturer wanted to upgrade the control setup of its fluidized-bed dryer. This was a legacy system that, through traditional push-button controls, only encompassed basic automated control.

A leading industrial automation specialist and system integrator helped the pharmaceutical company enhance the capabilities of the con-

trol setup by implementing a PLC-driven system (Figure 4). Incorporating human-machine interfaces (HMIs), control systems and supervisory control and data acquisition (SCADA) software, the upgrade also

opened the door to material tracking.

The manufacturer is now able to monitor feedstock throughout the entire manufacturing process, from raw material to end product. This enhanced level of traceability was complemented with the real-time generation of batch reports, offering key documentation for quality audits.

The batching of resources and dispensary control systems was also set up to create a fully integrated, autonomous solution. As a result of these improvements, the pharmaceutical major could increase the productivity of its fluidized-bed dryer by 50%, supporting a short payback time and considerable return on investment (ROI).

Case study 2: “Future-proofing” fluidized-bed drying operations.

Another leading pharmaceutical manufacturer wanted to enhance its process understanding in order to investigate to what extent its fluidized-bed drying operations could be improved, in terms of product consistency and processing time. To support this goal, the incorporation of an advanced process-control system within the existing unit was suggested. This would leverage a PAT framework, whereby moisture could be monitored in real time using inline near-infrared (NIR) spectroscopy.

Data from this additional analyzer, combined with those from existing sensors, would be fed to a multivariate analysis (MVA) model. The results would then be presented within a modern PAT knowledge platform, to visualize and facilitate effective decision making for operators and subject matter experts.

More precisely, operators could

determine the drying phases occurring in the fluidized-bed dryer in real time and adjust the temperature accordingly to maximize end product quality and processing times. The system could also provide live, endpoint control that supports data-driven downstream operations and their management, offering a highly interconnected, responsive setup.

By developing a more in-depth process understanding and real-time capabilities, the pharmaceutical manufacturer could improve both cycle times and product quality, benefitting from greater profitability and rapid ROI. Further, by leveraging PAT, the company could benefit from a futureproof, scalable setup to optimize other aspects of its manufacturing process.

Case study 3: Transparency for greater accountability in regulatory compliance. When a premier OSD-form manufacturer wanted to improve the visibility, accessibility and integrity of its fluidized-bed drying

process and product data, it looked at implementing secure and regulatory-compliant storage capabilities.

The data-driven capabilities of the existing system were enhanced by ensuring reliable data capture and storage within a state-of-the-art SCADA platform. In addition, an information-technology-company-managed data center was set up to enable the Medicines and Healthcare products Regulatory Agency (MHRA) to receive and visualize the data.

As a result, the pharmaceutical producer could strengthen its adherence to cGMP guidelines. The company then expanded this framework to additional production units.

Concluding remarks

Forward-thinking companies in a variety of manufacturing and processing industries are already experiencing the transformative impact of modern control solutions to regulate fluidized-bed dryers. By embracing system upgrades today to create ad-

vanced, interconnected, and data-driven setups, producers can catapult their competitiveness to new heights, yielding impressive ROIs.

As manufacturers look at advancing the capabilities of fluidized-bed dryers, they should partner with a leading industrial automation and system integration specialist. Collaborating with a full-service provider and industry expert can help them maximize the potential gains and support them throughout the entire equipment lifecycle. ■

Edited by Scott Jenkins

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Rotary Drum Maintenance

Follow these nine recommendations to establish a strong program for preventive maintenance of rotary drums in drying, cooling and other treatments of bulk solids

Maximizing efficiency is increasingly a critical priority for plant managers, leading many to move away from response-based maintenance programs to preventive, and in some cases even predictive, approaches to maintenance.

The same holds true when it comes to rotary drums — an essential component of many industrial processing facilities, particularly when it comes to drying bulk solids. As many plant managers are discovering, a robust preventive rotary-drum maintenance program has the potential to not only maximize efficiency, but also to minimize maintenance costs and downtime.

What follows are the key components of an effective preventive rotary-drum maintenance program, whether the drum is serving as a dryer, cooler, kiln or otherwise.

Inspections

Inspections are the foundation of any good preventive maintenance program, ensuring operators catch problems early, before they

have a chance to escalate.

Plant managers and maintenance supervisors should work with their original equipment manufacturer (OEM) to develop an inspection schedule tailored to their specific operating conditions. This is likely to include daily, weekly, monthly, quarterly and annual inspections, with specific points to address at each (Figure 1).

Making the most of inspections. Ideally, plant managers should provide operators and maintenance personnel with a checklist for each inspection interval, keeping detailed records of data points and any changes made for maintenance planning purposes.

In addition to in-house inspections, plant managers should also bring in the OEM or a qualified service provider to conduct an annual inspection on each unit. While this type of inspection will differ across providers, annual inspections generally provide a more in-depth assessment of the unit's mechanical condition, identifying any areas of concern, or components that will require future maintenance.

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IN BRIEF

INSPECTIONS
TIRE AND TRUNNION GRINDING
ALIGNMENT
TRAINING FOR PROPER DRUM FLOAT
MINIMIZING BUILDUP
MAINTENANCE AND LUBRICATION
SPARE WEAR-CRITICAL PARTS
TRAINING FOR DRUM OPERATORS
LEVERAGE AUTOMATION TECHNOLOGY
EQUIPMENT DESIGN



FIGURE 1. Regular inspections of drying equipment are a foundation of a good preventive maintenance program

Streamlining maintenance at multi-drum sites. Facilities with four or more rotary drums on site can benefit from monthly or quarterly dynamic inspections, in which one unit is shut down for a thorough, static inspection, while the remaining drums receive a dynamic inspection while they remain in operation. Each inspection visit focuses on a different unit, while also identifying issues to address at upcoming visits. This systematic



FIGURE 2. Grinding of tires and trunnions can address wear and superficial cracks

approach to rotary drum maintenance streamlines inspections and issue resolution, helping to minimize process downtime.

Tire and trunnion grinding

As the support system and contact points for the rotating drum, the tires (riding rings) and trunnion wheels tend to take the brunt of operational impact. Signs of an underlying mechanical instability typically show up in these components first, displaying as wear on tires, trunnions, or both.

Because these components support the rotating drum, a good preventive maintenance program will address any signs of wear promptly to avoid putting added stress on the drum and its many mechanical components, as well as to prevent exacerbating existing damage to tires and trunnions.

Visible wear and superficial cracks in tires and trunnions are easily addressed through grinding, a reconditioning process that abrades surface damage to reveal the like-new surface beneath (Figure 2).

Since wear on tires or trunnions typically indicates early signs of an underlying issue, operators observing wear must also identify the root cause of the issue to prevent wear from re-

suming after grinding. Most often, misalignment of the trunnions is to blame. This early identification of wear on tires and trunnions underscores the importance of regular inspections as part of a preventive maintenance program.

Alignment

Rotary drums can fall out of alignment due to a range of factors. A misaligned drum puts undue stress on the drum itself, as well as its many mechanical components. This can ultimately lead to tire and trunnion wear, bearing failure, gear damage and other problems.

In most cases, alignment refers to the structural alignment of the drum and its trunnion bases. However, drive components, as well as pinion and girth gears (where applicable), must also be in alignment for optimal mechanical stability. As such, trunnions, drive components and the pinion and girth gears may require routine realignment in order to rebalance the drum.

While the traditional manual approach to alignment is still carried

out, modern laser-alignment systems have made the realignment process much faster and more accurate (Figure 3).

Realignment should also be carried out after any major repairs have been conducted, particularly after the installation of new trunnion wheels, since these kinds of repairs can change base conditions.

Training for proper drum float

Regular training to ensure proper drum float is another important aspect of a preventive maintenance program. “Float” refers to the drum’s positioning between thrust rollers and is referred to as such because the drum should ideally float between rollers without putting excessive pressure on either one.

When a drum presses too hard on either thrust roller, which are in place to help to prevent the drum from drifting along its axis, the thrust roller and tire are strained, ultimately leading to mechanical instability, damage, and in severe cases, catastrophic failure of the tire or thrust roller. To avoid such issues, the drum should routinely be trained.

“Training” refers to the practice of skewing bearings at small increments to slowly reposition the drum along its longitudinal axis. It is important to note that this training should



FIGURE 3. Modern laser-alignment systems, like the one shown here, have led to faster work and greater accuracy

only be carried out by trained personnel, as even small adjustments made improperly can result in severe damage.

Minimizing buildup

Buildup prevention is a commonly overlooked aspect of rotary drum maintenance, and while it may seem harmless enough, the consequences of buildup can go far beyond poor housekeeping.

Allowing material to cake onto the rotary drum's interior can lead to uneven loading and subsequent mechanical stress, as well as process inefficiencies due to non-uniform heating. Buildup also has the potential to damage the drum if material breaks away in chunks and moves through the unit. Depending on the material, buildup may also encourage corrosive wear, reducing the equipment's service life.

As such, operators and maintenance personnel should regularly clean out the drum as production schedules allow. This not only provides the opportunity to remove any potential buildup, but it also gives personnel a chance to do a quick inspection of the drum's internals.

Rotary drums can also be retrofitted with knockers to help minimize buildup. Knockers, available in different designs, knock the drum as it rotates to dislodge any potential buildup. Ball-and-tube knockers remain a popular, low-maintenance option, while pneumatic hammer knockers offer increased control. Pneumatic hammer-knocker designs can allow operators to control strike interval, frequency and strength. They can also be maintenance-friendly, mounted on the outside of the drum (Figure 4).

It is important to note that managing buildup should not focus solely on the drum's internal processing environment. Managing buildup externally is important as well. Keep trunnion pits and other mechanical components clear of fugitive material and debris to minimize damage associated with abrasive wear and dust.

A drum that is clean both internally and externally can perform properly, as designed.

Maintenance and lubrication

While rotary drums are generally low-maintenance machines, their various moving parts require proper lubrication and routine maintenance. OEMs typically outline recommendations for this type of maintenance in the equipment manual.

In general, however, operators must ensure that bearings, chains, gears, reducers and other mechanical components are always properly lubricated and that any components exhibiting wear are replaced as needed. Oil should also be changed in gear boxes and reducers as recommended by the OEM.

Similarly, it should go without saying that internals, whether they are designed to contribute to process efficiency (flights) or protect the drum shell (liners, refractory and so on), should be replaced as needed to maintain process and equipment integrity (Figure 5).





FIGURE 4. A pneumatic hammer knocker mounted at the side of the drum can help to reduce buildup in the drum's interior



FIGURE 5. Drum internals should be replaced as needed for proper operation

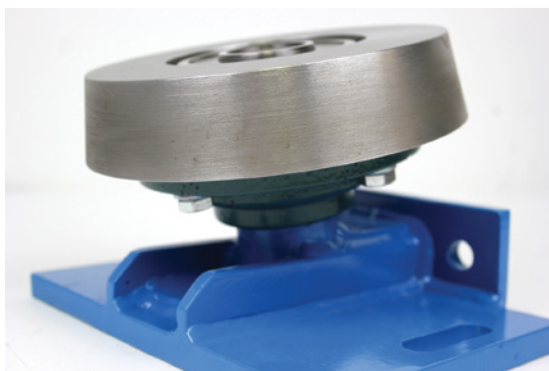


FIGURE 6. Plants should keep wear-critical parts, such as this thrust-roller assembly, on hand for faster replacement

Spare parts on hand

Part of a good preventive-maintenance program is keeping an inventory of spare and wear-critical parts on hand. Doing so facilitates a quick change-out in the event of a failure, or more importantly, allows maintenance personnel to replace worn or damaged parts before a failure can occur, as maintenance schedules allow.

Wear-critical parts such as trunnion wheel bearings, thrust roller assem-

blies (Figure 6), graphite blocks, and more, should all be on-hand to prevent a failure from holding the entire operation hostage. Keeping a parts inventory has become especially important in recent times, as supply chain issues have made part cost and availability highly volatile.

Operator training

While rotary drums are recognized for their simple operation, training for operators and maintenance personnel should still be a priority as part of a preventive maintenance program. Such training not only ensures operators avoid catastrophic mistakes, such as running the burner while the drum is in rotation, which can lead to shell issues due to localized heating, but it also familiarizes them with the machine. This helps them to recognize abnormalities that could indicate a problem. Worker training is also critical to personnel safety for those working in and around the drum.

Automation technology

Automation is fast becoming the future of preventive maintenance. While system capabilities differ, plant managers can enlist automation as part of their maintenance programs. These systems can alert operators when key parameters fall out of speci-

cation, allowing them to act before an issue can occur. They also give operators the process transparency to see where potential for trouble exists.

Systems with historical data-collection capabilities allow for long-term trending and reporting, which can be helpful in maintenance planning.

Equipment design

It is important to recognize that the best preventive-maintenance pro-

grams begin before the rotary drum is even built. Rotary drums perform best and have the longest service life when they are designed around the specific material characteristics and operating parameters at hand. This comes into play in the selection of mechanical components, materials of construction, configuration, and more. For this reason, plant managers should work with a qualified OEM to design their rotary drum according to their specific requirements.

Combined with a solid preventive maintenance program, a well-built rotary drum can provide decades of reliable service.

Concluding remarks

Due to its many benefits, preventive maintenance is quickly becoming the norm for managing capital equipment, rotary drums included. A solid preventive maintenance program gives plant managers a simplified approach to minimizing maintenance costs and downtime, while maximizing process efficiency.

An effective preventive maintenance program is multi-faceted and should consist of regular inspections, conducting regular adjustments such as grinding, alignment, and training, as well as minimizing buildup, following OEM recommendations, keeping an inventory of spare parts, and ensuring operators are properly trained. ■

Edited by Scott Jenkins

Editor's note: All photos appear courtesy of FEECO International

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Treating Wastewater in Bioprocessing Facilities

Bioprocessing facilities can achieve compliance, prevent downstream contamination and increase water reuse by using advanced oxidation processes

Alex Bettinardi
De Nora

IN BRIEF

BIOPROCESSING
PERMITS AND
STANDARDS

CONTAMINATION IS A
MAJOR LIABILITY

RECYCLING PROCESS
WATER

OZONE AOP TREATMENT

ULTRAVIOLET AOP
TREATMENT

AOP AND 1,4-DIOXANE

TOXICITY TESTING
PROTOCOLS

PILOTING CAN MINIMIZE
RISK

Wastewater generated from bioprocessing facilities is heavily regulated in the U.S. by the Environmental Protection Agency (EPA; Washington, D.C.; www.epa.gov) and various state laws. The primary goal of these regulations is to prevent contaminants and toxins that are present in bioprocessing-facility wastewater from entering sources of drinking water, which then must be treated by municipal water-treatment plants (Figure 1). An additional emerging area of interest focuses on water reuse — for both regulatory reasons and economic ones — because the cost to treat and reuse some wastewater can be far less than the cost of starting with untreated water.

Ozone advanced oxidation processes (AOP) offer exceptional benefits in achieving EPA compliance and reducing costs by recycling more water. Furthermore, AOP does an excellent job at preventing contaminants from leaching into groundwater and surface water, which can reduce a company's environmental risk and enhance its sustainability profile.

Bioprocessing permits and standards

The Clean Water Act establishes the basic framework for regulating pollutant discharges into the waters of the U.S. Depending on the nature and source of the discharge effluent, bioprocessing facilities that discharge into surface waters will likely require a National Pollutant Discharge Elimination System (NPDES) permit from the EPA. As a component of the NPDES program, the National Pretreatment Program addresses the discharge of industrial wastewater to municipal wastewater treatment systems, with standards that vary from state to state and city to city [1]. In ad-



FIGURE 1. There are numerous federal regulations in place to prevent contaminants and toxins from manufacturing facilities from entering sources of drinking water that must be treated in municipal waste-treatment sites

dition to bioprocessing activities, the EPA's Effluent Limitations Guidelines currently apply to 59 industrial categories, such as pharmaceutical manufacturing and food processing [2]. In some cases, bioprocessing facilities may be subject to the Spill Prevention, Control and Countermeasure (SPCC) rule, if they store, transfer, use or consume oil or oil-based products, such as diesel fuel, gasoline, lubricant oil, hydraulic oil, adjuvant oil, crop oil, vegetable oil or animal fat [3]. There are also numerous state and local regulations that can affect bioprocessing wastewater.

An emerging area of regulation that bioprocessing facilities should monitor are the new standards on per- and polyfluoroalkyl substances (PFAS), which are currently under development by the EPA. These additions to the National Primary Drinking Water Regulations under the Safe Drinking Water Act (SDWA) may have implications for bioprocessing facilities, especially those that discharge to municipal wastewater treatment plants.

Contamination is a major liability

Because living materials and components such as cells, bacteria and fungi are used to create products or act as catalysts within a

bioprocessing facility, wastewater from these facilities can be contaminated with nutrients, pathogens, organic compounds, chemicals and other contaminants of concern. To reduce risk, increase profitability and improve sustainability, bioprocessing facilities should invest in optimal wastewater-treatment methods.

By choosing not to fully treat their own wastewater, companies can expose themselves to litigation and regulatory fines, which have an immediate negative impact on profitability. Furthermore, certain methods of wastewater treatment enable significant water-recycling opportunities, which directly reduce operational costs and capital expenses. And finally, bioprocessing facilities that pass along contaminated wastewater to their local municipal treatment plants are pushing their external costs to governments and taxpayers, which can result in reputational and political damage.

In this day and age, there are zero upsides to not treating wastewater to the full extent available through technology and as required by regulation.

Recycling process water

Facilities that heat and treat water to make it ready for their manufacturing processes know full well the costs required. The cost of replacement water (which is increasing in many jurisdictions), the cost to prepare the water for the manufacturing process, the cost of chemical treatment and the cost to heat or cool the water all add up and represent a significant expenditure for the facility.

With the right technology and for certain parts of the process, process water can be reused, saving enormously on inputs required to prepare the water for the manufacturing process. As water availability continues to become less predictable around the world, companies that minimize their need for it also reduce their risk and increase their resiliency. And for the growing number of companies with sustainability commitments and goals, reusing water in manufacturing can help reach water targets and fulfill pledges to stakeholders.

Ozone AOP treatment

Ozone is a growing and appealing option for wastewater treatment. A pale blue gas, ozone is composed of three oxygen atoms (O_3). It is generated onsite and introduced into the wastewater to eliminate a wide variety of inorganic, organic and microbiological impurities, including contaminants of emerging concern, 1,4-dioxane micropollutants and cyanobacteria mycotoxins.

Inside an ozone generator (Figure 2), O_3 is produced when oxygen molecules are separated by an energy source into oxygen atoms, which react with other oxygen molecules to form ozone. A high-voltage alternating current is applied across a dielectric discharge gap that contains an oxygen-bearing feed gas.

When ozone is dissolved in water, the free radicals that are formed have excellent oxidizing capacity on pollutants and molecules. This process is generally preferred over other AOP processes, such as ultraviolet (UV) AOP, when the water has low UV transmittance



FIGURE 2. Ozone generators are used to produce O_3 gas that can be used to eliminate contaminants of concern from wastewater streams

or high total organic carbon (TOC) content, when peroxide quenching is a concern or if a plant requires the application of ozone for additional reasons, such as the mitigation of pharmaceutical micropollutants.

Ultraviolet AOP treatment

UV light alters the DNA of harmful organisms without the use of chemicals, rendering pathogens unable to reproduce and cause harm. UV affects waterborne pathogens that can infect humans, including protozoa, such as *Cryptosporidium parvum* and *Giardia lamblia*; viruses such as poliovirus and hepatitis A; and bacteria, such as *Salmonella typhi*, *Shigella*, *Escherichia coli* and *Vibrio cholera*.

UV AOP is also proven effective at inactivating 1,4-dioxane, as well as other harmful contaminants frequently discovered in wastewater, such as N-nitrosodimethylamine (NDMA). There are essentially two kinds of UV AOP: UV plus hydrogen peroxide; and UV plus chlorine.

With UV/peroxide, hydroxyl radicals are generated by the photolysis of hydrogen peroxide. During photolysis, the energy of the UV photon splits the hydrogen peroxide into two hydroxyl radicals, which are highly unstable and react within microseconds with contaminants in the water. The hydrogen peroxide is dosed and mixed in ahead of the UV reactor, and after photolysis, the treated water is released in the effluent.

With UV/chlorine, the chlorine dissolves in water to form hypochlorous acid (HOCl), which dissociates to form OCl^- at high pH — the higher the pH, the more OCl^- is formed.

Both treatment methods absorb UV and form hydroxyl radicals, but OCl^- is a significant hydroxyl scavenger, so even in small amounts, it can render the UV/chlorine process less efficient than using UV/peroxide. For this reason, UV/chlorine is used more often when the pH is lower, such as in potable reuse AOP where the pH of the reverse-osmosis (RO) permeate is normally less than 6.

AOP and 1,4-dioxane

Simply put, AOP is the best technology for treatment of 1,4-dioxane. The hydroxyl radicals generated by AOP are powerful oxidants that react with 1,4-dioxane contaminants and render them harmless. It is the most technically and economically feasible solution for treatment, because 1,4-dioxane is very soluble in water and therefore not effectively treated with granular activated carbon (GAC) or air stripping. Additionally, 1,4-dioxane will even pass through RO membranes, so AOP represents the most suitable treatment solution.

Toxicity testing protocols

Any industrial facility that discharges water directly

CASE STUDY

A manufacturing facility in West Virginia was dealing with the following two issues:

1. An effluent with a toxicity level that needed to be reduced by 50% to meet state requirements for groundwater discharge compliance
2. High costs for disposing of biological sludge

The site needed a disposal solution that could integrate with their existing plant, and they needed guidance on treatment strategies. Granular activated carbon (GAC) was considered, but rejected, due to high operating cost. UV was not applicable due to low UV transmittance and high organics content. The facility ultimately decided to pilot an ozone AOP treatment system. Among several reasons, ozone AOP was selected for its ability to oxidize the majority of the molecules causing toxicity, including surfactants, phenols, hydrocarbons, cyanide, pharmaceutical micropollutants, 1,4-dioxane and others.

The system dramatically reduced the toxicity of the plant's effluent to as low as 0, far surpassing state regulatory requirements and reducing the risk of fines and litigation. Also, the plant will save between \$100,000 and \$150,000 per year thanks to a reduction in biological sludge disposal. The pilot has now been converted into a permanent installation. □

into U.S. waters — oceans, wetlands, marshes, creeks, streams, rivers and lakes — is subject to oversight of the NPDES program according to the Clean Water Act. Part of this oversight requires that facilities regularly perform Whole Effluent Toxicity (WET) tests on their wastewater effluent.

The WET test measures the effects of facility wastewater on specific test organisms — specifically, their ability to survive, grow and reproduce. As



FIGURE 3. Before permanently installing a water-treatment system, it is helpful to vet the technology using an onsite pilot-scale skid system

opposed to testing for a specific chemical, WET is the aggregate toxic effect of an effluent. By observing the effect of a facility's wastewater on living aquatic plants, vertebrates and invertebrates, it can be established what the larger impact on an ecosystem and the safety of its water would be. There are two basic types of WET tests: acute and chronic.

Acute tests measure the immediate impact (such as mortality) of effluent on life forms that act as representatives of a general aquatic setting, and the test duration is usually 24, 48 or 96 h. The EPA recommends the use of ≥ 0.5 dilution factor, five effluent concentrations and a control for both freshwater and marine/estuarine effluent (although different organisms are used for freshwater and marine settings).

Chronic tests measure the longer-term impact of effluent, such as survivability, growth, mobility, fecundity, reproduction and teratogenicity (embryonic abnormalities). For chronic tests in freshwater settings, the EPA recommends the use of ≥ 0.5 dilution factor, five effluent concentrations and a control with a test duration of between four and eight days. For testing on marine/estuarine organisms, the test includes five effluent concentrations and a control, with a duration of between one hour and nine days.

The required frequency of a WET test is determined by

a facility's discharge permit and can range from monthly to annually, depending on substances handled by the facility and their potential risk to surface waters. Only third-party certified laboratories can perform these tests. Ref 4. Includes a list of methods and their corresponding test organisms.

Piloting can minimize risk

Wastewater and water treatment systems are a significant investment, so it is usually advisable to pilot the treatment before committing to a permanent installation. Most reputable suppliers will have a containerized, plug-and-play version of their products (Figure 3) with laboratory-scale testing that facilities can use for a limited period of time to confirm that the process will produce the desired results.

Piloting can overcome the challenges of variability presented by seasonality, weather and many other factors that affect water quality over time, as well as provide the opportunity to adjust certain parameters to design a system that will deliver the right treatment for the specific application.

One size most certainly does not fit all when it comes to water, wastewater and process water treatment, and the various applications, regulatory requirements, space allotment and optimal performance of each unique bioprocessing plant demands a tailored approach. Piloting will ensure that a plant invests properly and for the long term.

For bioprocessing facilities seeking to ensure that their wastewater complies with federal and state regulations and does not contaminate the surface water into which it discharges its effluent, the advanced oxidation processes described here can offer exceptional benefits, including reducing costs, increasing profitability, lowering risk and improving reputation. ■

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Advances in Chlor-Alkali Technologies

The products of the chlor-alkali process continue to be essential for many purposes across the global value chain. Modern chlor-alkali technologies can vastly improve upon the safety and environmental performance of legacy systems

Andy Liu
Chemours

The chlor-alkali production process is one of the most common of all industrial chemical operations. The output of a chlor-alkali system includes chlorine (Cl_2), sodium hydroxide (NaOH) and hydrogen gas (H_2) — all of which have broad application and growing economic and societal importance. For example, the free chlorine produced by chlor-alkali systems is the most affordable and widely used drinking-water disinfectant in the world. It is also highly effective against nearly all waterborne pathogens. Thus, chlorine serves an essential role as global demand for potable water continues to rise, alongside climate challenges related to rising temperatures and extreme weather events, which can lead to excess algae growth and increased sediment in natural water sources (Figure 1). However, despite its ubiquity, all chlorine is not created equally.

Available technologies

Today, most free Cl_2 is produced electrochemically by water electrolysis in equipment known as chlor-alkali cells. In standard chlor-alkali cell processes, a clean saltwater solution (brine) and water are converted into Cl_2 , H_2 and NaOH . Of the three common cell configurations, one type of legacy system uses mercury cells, while the second depends primarily on asbestos diaphragm cells. The third, more modern type uses polymer electrolyte membranes (PEMs).

The Minamata Convention, an international treaty signed by 128 nations in 2013, set a phaseout date of 2025 for using mercury in the chlor-alkali manufacturing process. After that date, chlor-alkali



FIGURE 1. As environmental stresses are challenging the availability of potable drinking water, chlorine is increasingly essential as an affordable and easily applicable treatment solution

electrolysis cells will be effectively limited to using diaphragm cells and PEMs.

In addition to the elimination of mercury and asbestos in the process, the advanced membrane chlor-alkali process using PEMs can enable substantial energy savings compared to the two older processes. In fact, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE; www.energy.gov/eere) has stated that, of the three available chlorine-producing technologies, the mercury cell is the most energy-intensive, consuming about 3,700 Kwh of electricity per metric ton (kWh/m.t.) of Cl_2 produced, while the diaphragm cell consumes about 2,900 kWh/m.t. PEM cells are the most energy-efficient, at 2,500 kWh/m.t. [1].

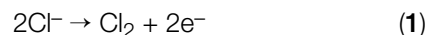
How membrane cells work

A chlor-alkali membrane cell is comprised of two half-cells, one containing an anode (positively charged) and the other a cathode (negatively charged), separated by a PEM (Figure 2).

A direct current is applied to the cell while a concentrated salt (NaCl)

solution, or concentrated brine, is fed into the anode side of the cell, and water is introduced into the cathode side. The PEM that separates the anode from the cathode is specially formulated so that it will conduct only positive sodium (Na^+) ions through it, while preventing passage of negative hydroxyl (OH^-) ions into the cathode side of the cell.

The negatively charged chloride ions are attracted to the positively charged anode, where they give up an electron to the anode and coalesce to form chlorine, which exits the anode half-cell as a gas:



At the same time, the negatively charged cathode attracts the Na^+ ions from the brine (anode) side of the cell, through the membrane and into the cathode half-cell. On the cathode side, the water is electrolyzed to produce negatively charged OH^- ions:



The Na^+ ions that have been transported from the anode side of

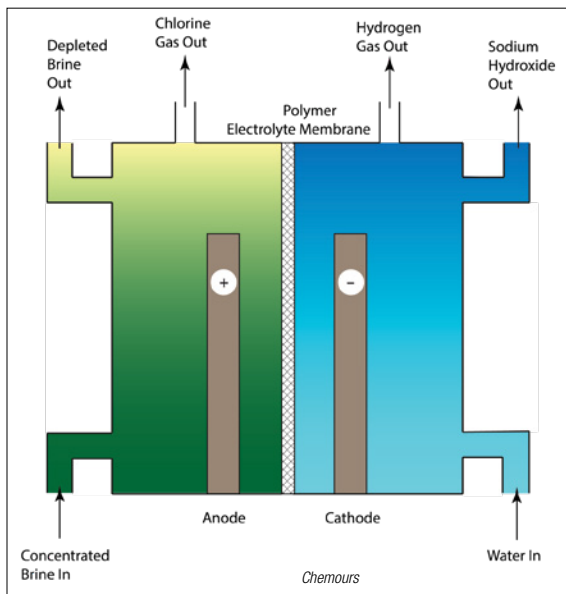
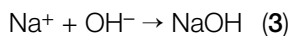


FIGURE 2. A typical chlor-alkali cell employing a polymer electrolyte membrane (PEM) is shown here

the cell combine with the OH^- ions produced at the cathode to form NaOH , commonly known as caustic soda or lye. The NaOH solution is discharged from the cathode side of the cell:



Thus, the membrane cell produces a depleted brine solution plus three saleable products — Cl_2 , H_2 and caustic soda — from the original brine and water input. The H_2 is becoming ever more valuable as an integral component of the growing hydrogen economy. The caustic soda has uses across the chemical and industrial landscape as one of world's most-used commodity chemicals. And finally, as mentioned previously, Cl_2 can be used to help improve water

quality and to make a host of chemicals, including sodium hypochlorite (bleach), a widely used, economical disinfectant that is effective against a wide variety of viruses and bacteria.

PEMs improve the process

Each chlor-alkali environment differs depending on the application, with variables including brine source and purity, water source and purity, electrical costs, available capital, and the labor force's experience level. Yet one thing remains constant across chlor-alkali facilities — a demand for consistent performance and energy savings.

Consistency and energy savings are crucial when scaling the production of commodities. Chlor-alkali membrane cells offer an environmentally sound solution for producing some of the most widely used commodity inorganic chemicals, through the industrialized electrolysis of NaCl .

The most efficient PEMs are ionomer based, meaning they selectively conduct ions over a wide range of operating conditions. This unique property enables membranes to create higher-quality and sustainable electrochemical separations, even in harsh environ-

ments. Additionally, modern, high-performance membranes offer consistent voltage performance, current efficiency, mechanical durability and high impurity resistance over the lifetime of the membrane.

This combination of properties leads to a host of advantages, including the following:

- Fewer process interruptions
- Limited maintenance downtime
- Reduced lifetime costs and total cost of ownership (TCO)
- Consistent production quantities
- Reduced lifetime energy use

Recent developments

Approximately 60% of the production costs involved in the chlor-alkali process come from the operation's power consumption. Any improvement in membrane voltage or current efficiency reduces overall cell energy consumption, thereby reducing operating costs. At the same time, the lower energy demands reduce the carbon footprint of the generating facility by reducing load and, thus, emissions.

The newest low-voltage membranes can reduce the power consumption not only in new chlor-alkali electrolyzers, but also in existing electrolyzers, if they are chosen at the time of membrane replacement. This is especially true if the low-voltage membranes retain the chemical and mechanical durability of their higher-voltage counterparts.

Because electrolyzer types and process conditions can vary among producers and individual plants, operators should consider the versatility of the membranes they choose. Some membranes for low-voltage performance are designed with the mechanical strength to resist damage from handling, installation and in-process pressure differentials and the chemical resistance to endure brine impurity spikes and impurity accumulations on the membrane, even as they resist degradation from power fluctuations. As membrane manufacturers continue to advance the design and robustness of PEMs, the chlor-

alkali process can be counted on to further improve energy efficiency and equipment longevity. ■

Edited by Mary Page Bailey

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Reducing Emissions for Sustainable Manufacturing

Facilities can reduce emissions without major capital projects. Here are some practical ideas showing where to start

Don Fregelette and Aurélien Tissot
Emerson

People working in the air-pollution control industry used to boast that you can remove everything from flue-gas except carbon dioxide, and it remains an accurate statement. With scrubbers, bag houses, chemical injection, catalyst beds, electrostatic precipitators, and other techniques, air coming out of a stack could be cleaner than it went in, except for CO₂. Yes, it can be captured, but that is an expensive process.

Carbon-capture aside, this article looks at several sources of emissions, and strategies for reducing them using a range of tools.

Regulatory bodies

First, we present an overview of relevant regulating bodies. Air pollution is regulated by local governments virtually everywhere in the world. In the U.S., it is the Environmental Protection Agency (EPA), and in E.U. it is the Industry Emissions Directive (IED).

In the U.S., the Clean Air Act is contained in the Code of Federal Regulations (CFR) Title 40, Chapter I, Subchapter C (Air Programs). Within this subchapter are many parts relevant to the chemical manufacturing sector, including the following:

- Part 63, National Emission Standards for Hazardous Air Pollutants for Source Categories
- Part 75, Continuous Emission Monitoring
- Part 76, Acid Rain Nitrogen Oxides Emission Reduction Program
- Part 84, Phasedown of Hydrofluorocarbons
- Part 98, Mandatory Greenhouse Gas Reporting

There are additional regulations under the U.S. EPA Air Emissions Factors and Quantification, AP-42, Fifth Edition, Compilation of Air Pollutant Emissions Factors, Volume 1: Sta-

tionary Point and Area Sources. Relevant chapters include the following:

- Chapter 5, Petroleum Industry
- Chapter 6, Organic Chemical Process Industry
- Chapter 8, Inorganic Chemical Industry
- Chapter 13, Miscellaneous Sources, including subchapter 13.5, Industrial Flares

The IED is also complex, and it covers the individual countries within the E.U. While it became significantly stricter on emissions limits in 2022, the regulations make some practical allowances, including the following:

- Individual countries can adjust specific regulations within reasonable limits
- The location of a facility can influence the extent of enforcement based on what surrounds it
- Allowance for local authorities to negotiate with the company to prioritize goals so compliance with local requirements is optimized, without unduly burdening the producer

For many companies, internally-set targets for various measures of sustainability exceed regulatory limits, driving the company to tighter emission reduction goals. Many have set net-zero targets in response to shareholders concerned about environmental, social and governance efforts. While these do not carry

the weight of law, corporate boards understand their importance.

Action plans for solutions

What strategies should companies consider for compliance with internally and externally applied emission goals? In some cases,

a new abatement process might be necessary, such as installing a scrubber or selective catalytic reduction unit to combat NO_x. Others may call for major feedstock and process changes, with significant capital expenditures required.

On the other hand, there are countless smaller efforts that can be made to tighten up operations. Each of these projects are modest in scale and cost, but they will result in a significant cumulative reduction of overall emissions. Since they can be applied selectively, it is possible to aim directly at bad actors in a facility, delivering the biggest bang-for-the-buck early in a program. These solutions use conventional technologies and can even be self-supporting financially because they save money as they reduce emissions.

Fugitive emissions

Fugitive emissions can be considered the “low-hanging fruit” when it comes to tackling emissions. Accounting for a third of a chemical plant’s total organic emissions, these unintended release events have many of the same usual suspects that should be examined first. Process units invariably give up process liquid or gas from two primary areas: process valves, either control or on-off; and pressure-relief valves (PRVs)

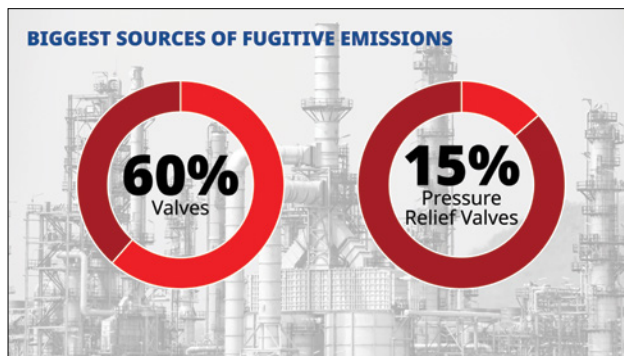


FIGURE 1. Together, valves and pressure-relief valves account for 75% of fugitive emissions

(Figure 1). This is a problem for two reasons. First, whatever is being released might be toxic or otherwise considered a pollutant. On top of impacting the environment, such emissions may result in fines from regulatory authorities. Second, even if the product is environmentally benign, it represents product loss, and all the feedstock and energy that went into making the product is simply wasted. Let's look at these two problems separately.

Valves. Valves are the leading source of fugitive emissions for most plants, therefore regulatory agencies focus on this asset class. The EPA has set standards for valve leakage, and even designed its "Method 21" procedure to determine if an individual valve is leaking. Globally speaking, the ISO15848 standard is another reference for both type and production tests. Because of the way they operate, valves' rubber parts tend to wear out and create a leak path. Now, to be sure, one individual valve may not be a major source of emissions, but across the number of valves in most process units, the cumulative effect is typically very significant.

Most leaks occur through valve stem seals, and this issue can be addressed by selecting the right valve, and then making sure it is properly maintained. The most effective valve-stem seals (Figure 2) use a combination of highly polished sur-

faces and live-loading of the seal material, so system pressure supports the sealing action, while self-adjusting packing pressure.

Pressure-relief

valves. PRVs leak because they do not close completely after a release incident. If the release has left debris on the valve seat, or if it is damaged, it may result in a slow leak, virtually indefinitely, which operators call "simmering."

This leakage may not be enough to cause problems with the process, but it does release product.

Another simpler reason is suboptimal technology selection. Spring-loaded "pop valves" are held closed by a spring, so their seat tightness decreases as system pressure increases. Consequently, a process that runs close to the set pressure has a high probability of releasing product. On the other hand, pilot-operated PRVs use the system pressure to hold the valve closed, so it can operate easily much closer to the set pressure. This minimizes the tendency to leak and waste product.

Selecting the right valve technology helps with both sources, but as explained earlier, we are talking about hundreds if not thousands of

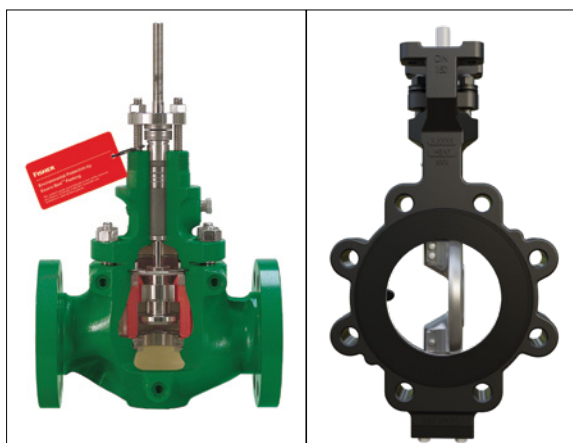


FIGURE 2. Live-loaded packing offers effective stem-sealing capabilities

valves, so monitoring is also needed to identify fugitive-emissions events. Organizations must also have accurate tracking and reporting of emissions data, which often means an investment in smart technology, such as wireless acoustic sensors or intelligent valve positioners, that can detect unnoticed emissions. Applying guesswork or manual monitoring of emissions is no longer a viable solution for organizations wanting to stay competitive and sustainable.

As a case-in-point, a study examining more than 10,000 PRVs found that 20% leaked at less than 50% of the set pressure, and 8% leaked so badly they did not pop properly at their set pressure. Consequently, monitoring the condition and activity of PRVs must now be part of normal plant operation, as required



FIGURE 3. An acoustic monitor is mounted on the discharge pipe of this PRV so it can report releases and ongoing leakage via a dashboard

by Title 40 of CFR 63 subpart CC. How should this be done? A properly-functioning PRV during normal operation makes no noise because nothing is flowing through it. When system pressure exceeds the set-point, it opens, releasing the contents of the system, either liquid, gas or both. This creates turbulence, generating noise that an acoustic monitor can hear and report to the automation system.

If everything is working correctly, when the pressure drops, the PRV will seal and the noise will cease. Data from an acoustic monitor can report the time the discharge began and ended, while giving some indication of how serious the discharge was, based on the amplitude of the sound. The problem is getting the valve to reseal.

Acoustic monitors can use the same WirelessHART network as other wireless field devices (Figure 3), providing an interface with a larger automation system, while also sending data to the maintenance team. With continuous monitoring, technicians can tell in an instant if a pressure release is underway, and if a valve has not fully resealed itself.

New application software provides a ready-to-use solution able to interpret information from an acoustic transmitter, identifying release events and ongoing leakage. This information can help minimize product loss, optimize maintenance efforts, and avoid costly unplanned shutdowns.

CO₂ from combustion

Burning any organic material — including natural gas, diesel, wood and so on — produces CO₂. In chemical processing plants, this likely includes over 90% of all heating processes, primarily boilers and fired heaters. Burning hydrogen, for instance, releases no CO₂, but such

installations are rare compared to those using fossil hydrocarbon fuels.

Processes that capture and sequester CO₂ from combustion sources are becoming more common, but are not yet widely deployed and require extensive equipment. So, for a plant wanting to reduce CO₂ emissions, what practical methods are possible, short of major equipment upgrades? The answer: make combustion as efficient as possible. Efficient combustion means delivering the required heat to the process while using the least fuel, and therefore producing the least CO₂. Achieving such efficiency requires careful fuel flow control and fluegas monitoring.

Fuel flow is often controlled by either pressure or volume measurement, however for quicker response and adjustments to today's often changing fuel composition, energy content must also be considered. For example, if a fired heater is designed for pipeline natural gas, but the plant decides to burn process off-gas with lower- or higher-heat content, the control system must compensate to avoid having output sag or wasting fuel. Many fuel control systems use volumetric flowmeters, such as differential pressure (DP) designs, which work well when fuel is consistent and thoroughly characterized.

However, if the fuel supply is variable, density and heat content will change. Fuel variability is a common enough problem that the American Petroleum Institute (API; www.api.org) established a subcommittee that explored its effects. It examined the problem using an independent software tool, developed to assess the impact such variable heat content can have on production costs if compensating adjustments are not made in real time.

A Coriolis flowmeter measures mass, so it detects such changes in real time, making fuel flow more closely reflect energy flow. This significantly speeds measurement and can result in annual savings of \$250,000 for a typical fired heater compared to control based on volumetric flow. This tighter and faster control allows a reduction in the operating oxygen target, often in a 2 to 5% range. This not only reduces energy intensity, but also has a direct impact on the reduction of different

emissions, including CO₂.

Monitoring the other end of the system is just as important. Most boilers and fired heaters have a continuous emissions monitoring system (CEMS) on the stack as required by regulators. Data from this should be sent to the burner-control system to ensure there are no changes suggesting a firing problem.

Another critical measurement is made by an O₂ sensor (Figure 4), used to determine if the mixture of air and fuel is optimal. Too much air over the stoichiometric requirement produces excess heat, with energy intensity increasing and excess CO₂ produced. A 2% increase of O₂ in the stack can increase emissions between 25 and 30%.

If there is too little O₂ in the fluegas, it suggests either not enough air or incorrect fuel combustion, which could result in a boiler or fired-heater trip.

An effective combustion-control system uses feed-forward control based on the fuel measurement and feedback control based on O₂ measurement to optimize fuel flow and air, delivering the maximum recoverable heat with minimum emissions. This will go a long way toward the goal of reducing energy intensity by 12% in chemical processing facilities by 2030.

Steam distribution

A steam-distribution system does not cause CO₂ releases itself. However, a poorly designed or under-maintained system does waste energy, causing boilers to consume additional fuel. It is common for steam generation to account for 40 to 50% of a facility's entire energy budget, so efficiency changes, for better or worse, can cause a substantial difference to the bottom line, and to emissions.

Steam-distribution systems need



FIGURE 4. A zirconia sensor (bottom left), used with an in-situ oxygen analyzer (top right), provides continuous measurement of excess O₂ from any combustion process



FIGURE 5. Vortex flowmeters are designed for leak-free performance over years of continuous operation. An integrated temperature sensor adds multivariable capabilities

careful monitoring and management to ensure steam is delivered to every application that needs it, while minimizing energy loss. This is harder than it sounds as the average efficiency of a typical system is only 56%, so more than 40% of the energy put into the

system is simply lost.

The ideal steam-distribution system optimizes the amount of steam distributed, monitors for losses and emissions and responds quickly to changing demand levels. Accurate measurement of flow, temperature, and pressure are critical for optimizing these systems.

Steam-flow measurement is critical because it is the basis for evaluating the effectiveness and efficiency of an entire steam generation and distribution system. While steam is simple in concept, the different types of steam used in industrial facilities require different considerations for measurement, as follows:

- Saturated-steam measurement ideally should compensate for density and energy changes, and it can be done with either temperature or pressure compensation
- Wet steam is the most complicated and is dependent on the amount of condensate in the line
- Superheated steam is more complex and should include both tem-

perature and pressure compensation

Facilities often use DP flowmeters for steam-flow measurement, and these can be very practical when supplemented with temperature and line pressure measurements.

Vortex flowmeters (Figure 5) measure flow via the frequency of alternating vortices formed as the fluid passes a bluff body inserted in the flow. Vortex designs provide less pressure drop, avoidance of impulse lines, greater turndown and improved accuracy. They also have high turndown ratios, so they operate easily where flow is highly variable.

Compensated vortex meters are available to provide improved steam flow measurement. The improved measurements provide a much better understanding of steam usage by the different unit operations in the plant and steam loss, along with a better picture of overall balance around the steam distribution system. This information can be sent to an energy management system (EMS) to provide more information, including im-



FIGURE 6. This commercial acoustic transmitter can hear steam trap activity and send data via WirelessHART to a dashboard reporting condition

proved targeting of bad actors.

One major area of energy loss is steam traps. They are supposed to open and close automatically to release condensate accumulations in steam lines. Thermodynamic traps are very simple, with only a single moving part, whereas mechanical designs (such as float and inverted bucket) are more complex. Unfortunately, over time they can all malfunction.

Particulate matter and scale can lodge in valve seats or mechanisms. Operating conditions, such as cor-

rosion, water hammer and vibration, also take a toll. A steam trap can fail open and release steam, or stick closed, backing up condensate. A recent study suggests that 18% of steam traps in a large chemical manufacturing facility can fail each year, resulting in wasted energy costs up to \$16,000 per trap.

Detecting failed steam traps is essential for steam system safety and emissions control. A failed-closed steam trap will back-up condensate into the main steam header and

create wet and inefficient steam, and it will create safety hazards from water hammer.

A failed-open steam trap vents steam to atmosphere, requiring additional steam from the boiler. Once bad actors are identified, steam systems and steam trap installations may require modification to reduce steam trap failure rates, and to ensure the driest possible steam is available system-wide to maximize heat transfer, thereby reducing the need to burn more fuel in the boiler.

Failure detection can be automated by adding an acoustic transmitter (Figure 6) on the adjacent pipe. It listens for the characteristic sounds of the trap opening and releasing condensate. An algorithm learns the characteristic activity for each trap. The transmitter sends data via WirelessHART to a central data collection and analysis platform, where operators can see how steam traps equipped with acoustic transmitters are performing.

Dashboards display which steam

traps are working correctly, and which are in failure mode. The software estimates lost energy, and resulting costs, as well as estimating impact on CO₂ production. Maintenance personnel can see at a glance which steam traps need attention and plan activities appropriately, and they can predict and deal with small problems before they become serious issues.

Process & energy management

Managing the actual manufacturing process and overall energy usage is necessary to keep the plant operating stably and optimally. This in itself reduces emissions because it eliminates waste from end-to-end. Achieving this condition is difficult because mass and heat balancing is complex with many variables. Effective process automation is paramount to accomplish these objectives, and new digital tools make it possible to reach a wide range of key performance indicators simultaneously.

Implementing an energy management system (EMS) supports optimization of energy efficiency and reduced energy consumption. It involves a set of tools and procedures for monitoring, controlling and optimizing energy use — including electricity, gas and water — to reduce costs, improve energy performance and reduce greenhouse gas emissions. An EMS typically includes a control system, historian and analytical software

designed to provide dashboards and reports to the right people, who can use this improved information to analyze and set priorities.

A digital twin is also an excellent platform to analyze complex relationships because it provides a mechanism to simulate a range of what-if scenarios, so decision makers can evaluate the predicted results and risks of various changes to overall plant performance and revenue. For example, plant personnel may suggest an equipment change to help increase production and reduce energy consumption. A digital twin can provide a detailed analysis to determine how the change will affect the overall operation, and if the project goals will be met as expected. Decision makers can use this tool to maximize the economics of business decisions by going beyond the equipment level and accurately predicting future asset performance of the entire production process.

Integrated solutions

Launching a sustainability initiative, with either a series of incremental changes or a major capital project, is much more successful when working with the right partner able to bring a portfolio of products to the effort, combined with deep domain expertise. Success requires effective strategy and planning, and the right partner makes a huge difference. ■

Edited by Gerald Ondrey

Acknowledgment

All figures courtesy of Emerson.

Authors



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Aurélien Tissot is the Europe marketing director at Emerson (8 Imp. de la Madelon, 69800 Saint-Priest, France; +1-888-889-9170; Email: aurelien.tissot@emerson.com) looking after product lines encompassing valves, actuators and regulators. In the past two years, he has led sustainability programs globally, covering energy and emission for the petroleum-refining industry; carbon emissions capture, utilization and storage; and renewable natural gas. Since joining the company in 2007, he has held several roles in engineering, product development, strategic planning and business development. Tissot earned a master's degree in mechanical engineering from the University of Troyes in France, and an executive MBA from La Sorbonne in Paris.

POWTECH 2023



IKA-Werke

From September 26–28, the bulk solids and conveying technology industry will gather at the Nuremberg, Germany exhibition halls. Powtech 2023 is a leading trade fair for processing and bulk-solids technology, with exhibitors from a number of sectors of the chemical process industries (CPI), including chemicals, pharmaceuticals, food, non-metallic minerals, ceramic, glass, machine and equipment manufacturing, recycling, environment technology, cosmetics and batteries. Both established companies and start-ups will present a wide range of technological solutions for the production and processing of powders, granules, bulk solids, fluids and liquids. The following is a preview of some of the products being exhibited.

Two-stage solid-liquid mixing in batch operation

The CMX 2000 is an inline mixer for fast, homogeneous incorporation of powders into liquids. The circulation of the liquid creates a strong vacuum in the machine, which sucks in the solid material. Thus, even powders that are difficult to wet can be incorporated lump-free into a liquid phase. The two-stage design with a pumping and dispersing stage ensures stable functionality even at high viscosities. Due to the highly efficient mode of operation of the CMX, production time and raw material usage can be saved. The CMX is usually supplied as a system with solids dosing and a mixing vessel. Depending on the application, the solids feed can be designed as a big bag system, via a hopper, by means of a sack chute or a suction lance directly sucking from the sack (photo). The CMX can be installed horizontally or vertically and has a low installation height. The closed system prevents dust and solvent emissions. Hall 2, Stand 510. — IKA-Werke GmbH & Co. KG, Staufen, Germany

www.ikaprocess.com

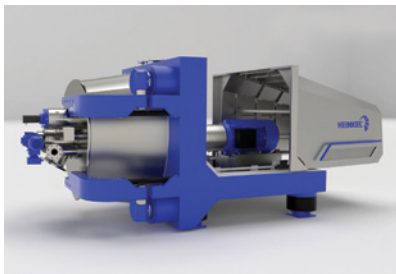
A new peeler centrifuge with patented features

The Bluetector is this company's new generation of horizontal peeler centrifuges. Features of the new brand include an optimized and patented hous-

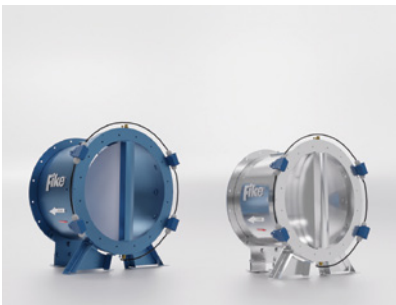
ing shape (photo), which permits the efficient drainage of filtrate through the rear wall without any additional guidance for the liquid. A slidable machine cover reduces noise emissions and contamination of the technical area, providing quick and easy access. The Bluetector is equipped with only electric drives — also in hazardous areas up to ATEX zone 1 — ensuring excellent cleanliness without hydraulic oil and belt abrasion. The intelligent drive concept minimizes friction losses and enables the use of an optimized electric motor, without a belt drive. This means shorter batch times, lower energy consumption and lower operating costs, says the company. The new peeler allows low-shear and gentle product discharge and protects the discharge chute from contamination. Hall 4, Stand 319 — Heinkel Process Technology GmbH, Besigheim, Germany
www.heinkel.de

This explosion-isolation flap is now available in stainless steel

The DFI explosion-isolation flap valve (photo) is safe for use within food production and chemical plants to protect against rust, paint or other contaminants from entering the product. Currently available in sizes from 4 to 32 in., the DFI is also now available in 40 in. (DN1000) for the traditional version. This allows DFI to be used in even larger dust collectors or other industrial applications that convey organic dust. DFI includes two flaps on a vertical center-bar hinge that are held open by normal process flow. When a deflagration occurs, the pressure reverses the flow and quickly closes the lightweight flaps into a locked position strong enough to withstand the explosion pressure. The compact, fast-closing flaps allow installation close to the vessel and elbows in both horizontal and vertical ducts, depending on DFI size. The device withstands high explosion pressures up to 1.5 barg from ST1, ST2, light metal and low-MIE (minimum ignition energy) dusts. By simulating real-world conditions, it will experience in the field, the DFI exceeds testing standard EN16447. Hall 1, Stand 236 — Fike Deutschland, Weinheim, Germany
www.fike.com



Heinkel Process Technology



Fike Deutschland

Increase yields with this heel-break system

This company is presenting its Heel Break System for the Pressofiltro filter dryer (photo). The device breaks up the heel remaining after the product discharge, thus achieving a heel-free product discharge and the highest possible yield of the valuable product. By pressurizing the multilayer filter plate with bursts of nitrogen, the heel breaks up and is discharged by the agitator. This is particularly effective in combination with the Whirl Snake Turbine, which uses nitrogen to blow any product remaining on the filter plate toward the discharge port. The mixing shaft and the rotating nozzle head, rotating at the same



Comber Process Technology

time, ensure that all areas in the vessel are covered and the remaining product is completely removed. As an alternative to manual emptying via glovebox, the Heel Break System enables a contained and automated process cycle. Hall 4, Stand 319 — *Comber Process Technology S.r.l., Agrate Brianza, Italy*

www.heinkel.com

Laboratory and pilot testing are the focus at this stand

At Powtech, this company is placing a special focus on laboratory and pilot trials. At the stand, two different process steps in the laboratory and in the test center will be exhibited. The company will also present a new laboratory indexing filter, a compact version of the proven indexing belt filter. This continuously operating vacuum filter separates solids from suspensions safely and gently. Also on display is the type HTC-T 140 horizontal dryer (photo), which efficiently dries processes that have a



high energy input in the chemical industry, as well as in starch, cellulose or battery production. The continuous and efficient mixing of the drying product enables optimum utilization of the hot heat-exchange surface and produces uniform product quality. Hall 4A, Stand 213 — *BHS-Sonthofen GmbH, Sonthofen, Germany*
www.bhs-sonthofen.com

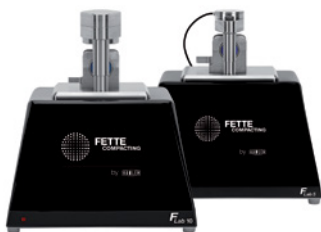
'Green' initiatives launched for 50-year anniversary

This specialist for explosion-safety and explosion-venting offers cross-industry safety concepts for plants and equipment. All products, from

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Rembe GmbH Safety+Control



Fette Compacting



BOLZ Process Technology



Haver & Boecker



Maschinenfabrik Gustav Eirich

rupture discs to explosion-protection systems, are manufactured in Germany and meet the requirements of national and international regulations. Its products are used in various industries, including the food, timber, chemical and pharmaceutical industries. To mark its fifty-year anniversary, the company has launched several initiatives. For example, the company's WeltWald (photo) was launched last year, whereby 8 hectare of forest are being reforested in cooperation with the Brilon municipal forest and the Bürgerwaldverein Brilon. The bark-beetle plague destroyed a large part of the Brilon municipal forest. Trees from all over the world were planted and now their growth under the changed climatic conditions is being observed. The diversification will help to make the tree populations more resilient in the long term. The project is being implemented in cooperation with the University of Göttingen. Hall 1, Stand 429 — *Rembe GmbH Safety+Control, Brilon, Germany*

[www.remb.de](http://www.rembe.de)

Analyzing powders for optimizing tableting formulations

The F Lab powder-compaction analysis (PVA) unit is available in two versions (photo). As an analyzer, formulations can be examined to determine their compaction processability. Users can test raw materials under special conditions and compare different formulations. The compact, easy-to-operate unit detects even the smallest compaction variations of powder mixtures due to a change in composition. The F Lab 5 version has a pressing force of up to 5 kN, and is suitable for tablet sizes up to 10 mm. The F Lab 10 achieves a pressing force up to 10 kN for 15-mm sized tablets. Associated software combines data from the F Lab with results from other analyzers and visualizes the evaluations in clear diagrams on a dashboard. Hall 2, Stand 409 — *Fette Compacting GmbH, Schwarzenbek, Germany*

www.fette-compacting.com

This dryer comes with a variety of agitators

The Cylindro conical dryer (photo) can be adapted to almost any pro-

cess requirement and can be used as a vacuum contact dryer and evaporator, as well as a sterilizer or alkalizer. The efficient Cylindro conical dryer is often used after mechanical solid-liquid separation, but can also be operated without a preceding mechanical-separation stage. The products processed range from slurries and pastes to filter cakes, granulates and powders. It ensures the highest quality and short drying times and achieves final moisture contents of just a few parts per million (ppm), depending on the requirements. The different mixing unit designs, such as helix, double helix, paddle or spiral segments, make it a multi-purpose dryer. Hall 4, Stand 319 — *BOLZ Process Technology GmbH, Wangen im Allgäu, Germany*

www.heinkel.com

Aggregated bulk solids and filtration expertise

This company's Wire Weaving division is focusing on all the variations of ultrasonic screening. Screening systems equipped with frequency variation (photo) ensure more efficient screening by improving screening throughput, promoting the grinding of agglomerates, reducing oversized content and permanently cleaning the screen. When used in silos, ultrasonic action gently ensures better separation and conveying of bulk materials. In addition to industrial screening, the metal wire-mesh products are being exhibited as solutions for demanding filtration tasks. Also at the stand are several of the company's joint ventures (JVs), Aventus and Nexopart, and technology subsidiaries Behn+Bates and Quat2ro. Nexopart is a JV with Hosokawa Alpine that offers products and services for particle and dynamic image analysis of sieving operations. Hall 1, Stands 537 and 533 — *Haver & Boecker, Oelde, Germany*

www.haverboecker.com

World premiere for a new laboratory mixer, and more

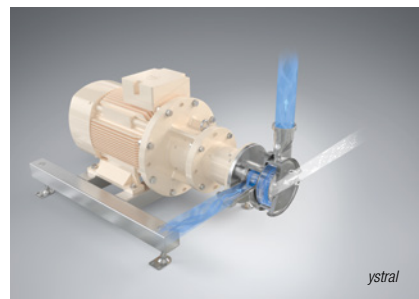
The new EL5 laboratory mixer (photo) is smaller, more lightweight and "smarter" than its predecessor, while delivering the same high levels of performance and robustness.

The 5-L machine features easy operation, scalability, integrated tilt adjustment and options for day-to-day laboratory operations. These include recipe management, data collection and network capability. The company is also exhibiting its digital solutions for process optimization, which use autonomous analysis tools, artificial-intelligence (AI)-based process assistance systems, and — as a new feature — product characterization with deep learning. Already presented last year as a specialist solution for granulation, QualiMaster VC1 is equipped with a special camera that continuously records, processes and analyzes images from the product conveyor belt. In the process, the system identifies and calculates numerous parameters and product properties from the images. The new QualiMaster VC2 features a universal camera system for automatic trend detection via AI-based image analysis. Hall A4, Stand 403 — Mas-

chinenfabrik Gustav Eirich GmbH & Co. KG, Hardheim, Germany
www.eirich.de

Energy-efficient mixing and dispersion technologies

The Conti-TDS powder wetting and dispersing machine (photo) is available in two sizes: Conti-TDS 2 and 3. In the Conti-TDS, the processes of wetting and dispersing are concentrated in a dispersing zone with an effective volume of only about a quarter of a liter. Compared to a dissolver operated in a vessel, the disperser generates about 30,000 times higher volume-specific power, which is crucial for successful dispersion. Using a rotor-stator system, the disperser also builds up shear forces that are 1,000 times higher. The dwell time is extremely short, so that only a fraction of the energy is needed compared to the High Speed Dissolver. At the stand, the company is presenting the Conti-TDS 2 together with a Jetstream Mixer as a compact



process system. The Conti-TDS 3 disperser will be presented together with a Jetstream Mixer, a textile silo and the Flex FSA discharge aid for poorly flowing powders as a complete process system. In addition, the Multipurpose unit with the X100 tool shaft will be presented. By simply exchanging the shafts, Multipurpose systems can realize different tasks such as jet mixing, mix-dispersing, dispersing and wetting powders with only one system. Hall 4, Stand 215 — *ystral Group, Ballrechten-Dottingen, Germany*

www.ystral.com

Gerald Ondrey



Metrohm USA



Rotorflush Filters



Bedford Reinforced Plastics



Process Wastewater Technologies

This year's Weftec technical exhibition and conference (www.weftec.org) is taking place Sept. 30–Oct. 4 in Chicago, Ill. The event will highlight the newest technologies to address water- and wastewater-treatment challenges. This preview highlights a small selection of Weftec exhibitors.

Determine water hardness using photometric titration

This company's Optrode sensors are designed to provide accurate and reproducible results for total water hardness in automatic photometric-titration processes. ASTM method D8192 describes the automatic determination of the calcium and magnesium content (hardness) of industrial and domestic water samples using a photometric sensor. In combination with a digital titrator, optical sensors, such as the Optrode, register the color change of the titrant automatically, providing accurate and reproducible results even for colored samples. Advantages of the new standardized measurement method include simplified maintenance — the sensor must only be rinsed prior to measurement. The Optrode sensor can be used with automated systems for high-throughput analysis. With the Optrode sensor, detection limits from 2 to 5 mg/L CaCO_3 are feasible, enabling easy compliance with the requirements of ASTM D8192. Booth 436 (South Building) — *Metrohm USA Inc., Riverview, Fla.*
www.metrohmusa.com

Self-cleaning pumps with a high-performance intake filter

Originally designed to overcome blockages when pumping dairy-farm wastewater, this company has developed a submersible pump with an integral self-cleaning intake filter equipped with a backflush rotor. This configuration is said to be a good alternative to a separate suction filter with a surface-mounted pump. It is easy to install because no additional pipe work is necessary. The filtered output protects nozzles and upstream equipment from blockage. Initial offerings were in the 1- to 3-hp range and were designed for use in small irriga-

tion systems, open-loop heat pumps, washwater for sewage works and sample preparation for water analyzers and monitoring equipment. Over the last few years, much larger submersible pumps have been introduced to the series with flows up to 3,000 gal/min and pressures up to 170 psi. Booth 8401 — *Rotorflush Filters Ltd., Charmouth, Dorset, U.K.*

www.rotorflush.com

Modular FRP structures designed with compliance in mind

ReadySeries is a range of modular structures (photo) designed for compliance with OSHA requirements. Constructed of fiber-reinforced plastic (FRP), ReadySeries structures are resistant to corrosion and fire, and are non-conductive, unlike metal and wood structures. ReadySeries structures are equipped with anti-slip coatings to minimize fall and slip risks. Safety yellow coloring is available for all relevant components. The ReadySeries system includes industrial platforms, mezzanines, walkways, catwalks, fixed ladders, handrails, guardrails, stairs, stair towers, pedestrian bridges and more. Each easy-to-install modular product can be used independently or combined with other products in the series for nearly limitless configurations. Booth 4720 — *Bedford Reinforced Plastics, Bedford, Pa.*

www.bedfordreinforced.com

Modernized dewatering concept for challenging sludge

The PWTech Volute DUO (photo) adapts the original dewatering drum concept for more efficient dewatering of difficult sludges. When dewatered, sludges that contain a high concentrations of fibrous, inorganic or adhesive material can form a compacted cake that can be difficult to extrude from a traditional screw press. This can lead to clogging and may require reducing cake solids to avoid plugging. Utilizing twin counter-rotating screws inside a single drum to break up and move feed solids for dewatering, the DUO enables maximum cake solids without compromising performance. Using a separate drive mechanism — so that the moving rings do not contact the

screws as they move — the DUO design also further reduces wear on the press, resulting in many years of maintenance-free operations. The DUO can be utilized in virtually all sludge dewatering applications. However, it is especially effective in applications that would otherwise create plugging or binding in more traditional screw press designs. Booth 1648 — *Process Wastewater Technologies LLC, Rosedale, Md.*
www.pwtech.us

This rake automatically adjusts its speed for changing flow

The FlexRake IQ (photo) enhances solids handling by sensing conditions and speeding up or slowing down to accommodate changing debris and flow in real time without user intervention. To maximize uptime, large debris is managed without shutdown, and the FlexLink system ensures that scrapers return to cleaning the screen field faster. The scrapers have an enhanced tooth profile and unique

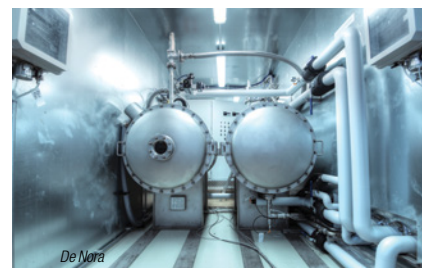
collection geometry that handle plant washdown and wastewater debris, while removing solids cleaned at the higher speed. The new design of the FlexRake IQ focuses on smart enhancements to the raking device that extend the life of mechanical components. Users are able to manage heavy solid-loading events with a large debris-removal capacity, improved grit and rock handling and greater solids capture. Booth 1600 — *Duperon Corp., Saginaw, Mich.*
www.duperon.com



able with throughput capacities up to 6,000 lb/d (113 kg/h). The systems use this company's proprietary XTL dielectric technology to decrease maintenance costs and increase uptime. Piloting options can help overcome the challenges of variability persistent in industrial applications. Skid-mounted and containerized systems are available for temporary and mobile systems during this phase, which can later be combined with other technologies, such as ultraviolet (UV) treatment, to solve multiple issues on site. As part of an advanced oxidation process (AOP), ozone presents an appealing option to reduce whole effluent

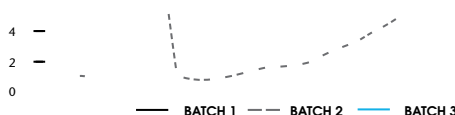
Reduce industrial wastewater toxicity with advanced oxidation

The Capital Controls range of ozone-generation systems (photo) are avail-



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toxicity (WET), since it offers a short reaction time, requires no additional chemicals and reduces disinfection byproduct formation. Booth 1406 — *De Nora S.p.A., Milan, Italy*
www.denora.com



Mentor APM

Enterprise asset management for complex process environments

This company's application platform (photo) is designed to handle the rigors and demands of effectively managing assets in any complex process environment. The application, its architecture and all its detailed asset libraries integrate asset-performance management and decision support

with optimized work execution in a complete enterprise platform to offer clean decision-making support for targeted priorities. Embedded best practices and asset-management intelligence optimize any operation for a sustainable future. The software also helps establish lines of sight from management to field crews, providing a single source of truth for asset information, and helping break down silos and build consensus on priorities. Booth 4516 — *Mentor APM, Phoenix, Ariz.*

www.mentorapm.com

Inspect and maintain sewer systems with this digital platform

PipeInsights (photo) is a digital platform designed for rehabilitation and maintenance of sewer systems. The PipeInsights platform augments conventional inspections using advanced machine-learning algorithms to provide automated defect detection and recommend optimal maintenance decisions. By seamlessly integrat-



AECOM

ing CCTV footage and results into a simple geographic information system (GIS) interface, the PipeInsights platform enables users to manage multiple sewer programs simultaneously while enhancing understanding of overall sewer-system health. To date, PipeInsights has been used on real-world inspections and captured hundreds of thousands of defects as it continues to learn. The platform enables secure access to inspections from mobile devices, allowing users to visualize and share the health of their systems from the office or the field. Booth 4620 — *AECOM, Dallas, Tex.*

www.aecom.com

Mary Page Bailey

Water Management

special advertising section

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A Better Alternative to Sludge Heating: Direct Steam Injection (DSI) heaters from Hydro-Thermal

Maintaining a constant sludge temperature in the Agricultural, Industrial, or Municipal markets can be challenging. Sludge heating is typically performed using indirect heating methods, like a heat exchanger. Hydro-Thermal Direct Steam Injection (DSI) heaters like the Non-Obstructive Heater (NOH) are ideal for heating and maintaining the digester's required temperatures for mesophilic or thermophilic digestion. In controlling an accurate temperature throughout digestion, the end user can see increased Biogas production and reduced hydraulic retention times in their digesters.



Cross Section of Hydro-Thermal Non-Obstructive Heater (NOH) Heater

The NOH heaters provide a straight flow-through design like a spool piece, ensuring that wipes, rags, or debris do not clog the heaters like in a heat exchanger.

Compared to heat exchangers, DSI heaters control the process fluids more efficiently, resulting in significant energy cost savings and handling high viscous slurries without any burn-on. Furthermore, Hydro-Thermal's NOH design reduces maintenance costs since no specialized tools are required for cleaning. Unlike other heating systems, the heaters also resist grit and abrasive materials.

Hydro-Thermal's DSI technology occupies less space than traditional heat exchangers, resulting in a smaller footprint. The heaters can be easily installed into existing piping systems, requiring minimal floor space and eliminating the need for a separate condensate return system. This makes installation significantly more cost-effective than other heating methods.

Overall, Hydro-Thermal's DSI heaters provide an effective solution for wastewater treatment. They ensure precise heating, require less maintenance, and occupy less space than conventional heat exchangers. These benefits ultimately lead to cost savings and optimize the anaerobic digestion process.

www.hydro-thermal.com/wastewater



NOH heater installed

Water Quality Analysis Tool Replaces up to 6 Lab Instruments

The Myron L Company's Ultrameter II 6PFC^E delivers benchtop lab-accurate measurements in one compact, easy-to-use, easy-to-calibrate handheld device.

The Ultrameter II 6PFC^E provides a comprehensive suite of in-situ water quality analysis tools designed to replace more costly and less convenient laboratory equipment. A true, one-handed instrument, the 6PFC^E delivers Conductivity, Resistivity, TDS, pH, ORP, Free Chlorine Equivalent (FC^E), and Temperature measurements quickly and easily with the press of a button. Simply rinse and fill the sensor well and/or cell cup with solution, press a measurement key, and note the measurement value or store it in memory. With the optional bluDock accessory package, the 6PFC^E can transmit data wirelessly to the free Myron L Guardian² desktop application. This application saves data in .mlcx files in a secure, encrypted format. For users who wish to view and/or manipulate data in other applications, Guardian² can export data files in .csv, .xls, .xlsx, and .pdf formats.

Unlike other similar meters, the 6PFC^E

Conductivity/TDS function features three modes that model the composition of water in the most commonly encountered testing environments in industrial systems: KCl, NaCl, and Myron L's own 442 Natural Water Standard. The result is benchtop accuracy of $\pm 1\%$ of reading in a handheld instrument. Temperature compensation is automatic to 25°C or can be disabled by the user as required. When working with a known solution, the user can program a temperature compensation ratio and a Conductivity to TDS conversion ratio in User mode. Autoranging capabilities provide increased reading resolution across a broad range of applications.

pH readings are also temperature compensated. The user can choose to perform a 1-, 2-, or 3-point calibration depending on the range of samples measured to achieve ± 0.1 pH accuracy. The pH sensor is of a proprietary construction and includes a large



potassium chloride reference solution reservoir for long life. Myron L pH sensors are also user replaceable.

ORP measurements utilize a 99.9% pure platinum electrode and a reference junction that is shared with the pH sensor. Accuracy achieved is ± 1 millivolt.

In addition, the 6PFC^E features a groundbreaking new way to determine Free Available Chlorine based on a predictive ORP value. Empirical measurements of the chemical activity of a solution are made without the hassle and subjectivity of colorimetric and test-strip methods.

Calibration and maintenance are simple, so the 6PFC^E can be serviced by the user. The 6PFC^E is also IP67 dust-tight and waterproof, NEMA 6 submersible, and buoyant. Plus, Myron L service and technical support are included for the life of the product.

www.myronl.com



**Written for engineers,
by engineers**



More and more, business in the Chemical Process Industries (CPI) is not local, it's global. To keep up with this rapidly evolving marketplace, you need a magazine

that covers it all, not just one country or region, not just one vertical market, but the entire CPI. With editorial offices around the world, Chemical Engineering is well-positioned to keep abreast of all the latest innovations in the equipment, technology, materials, and services used by process plants worldwide. No other publication even comes close.

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Future-proof valve automation for the water industry



Smart and versatile: AUMA PROFOX actuators on ball valves

Providing fast and precise positioning, utmost flexibility and reliability, and low operating costs, AUMA PROFOX actuators offer high-performance valve automation solutions for water treatment and desalination plants, including mobile containers and skids. Compact in size, PROFOX actuators fit tight spaces.

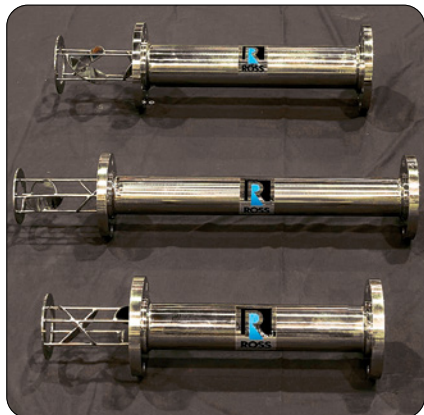
Built-in intelligence and flexible interfaces future-proof PROFOX for modern plant automation. Robust design ensures long life even under the toughest process conditions. PROFOX actuators are easy to use, with rapid installation and commissioning.

www.auma.com

Static mixers with low pressure drop

Ross LPD Low Pressure Drop Static Mixers are ideal for effective fluid mixing in water and wastewater treatment processes

The **Ross** Low Pressure Drop (LPD) Static Mixer enables more efficient dosing of flocculants, disinfectants, neutralizing



Four or six mixing elements are usually more than sufficient for effective mixing under turbulent flow conditions, Ross says. Diameters range from 1 in. through 48 in.

agents and pH conditioners into a water stream. This simple-to-install heavy-duty device completely mixes treatment chemicals within a short length of pipe. When used in conjunction with automated instrumentation, the LPD delivers predictable quality control based on a virtually maintenance-free operation.

The LPD Static Mixer consists of a series of baffles or “elements” discriminately positioned in series. Each element comprises a pair of semi-elliptical plates set 90 degrees to each other. The next element is rotated 90 degrees about the central axis with respect to the previous baffle set, and so on. For even lower pressure drop, an LLPD model is also available, in which the plates of each element are oriented at 120 degrees relative to each other.

As the fluid moves through each LPD or LLPD element, flow is continuously split into layers and rotated in alternating clockwise and counterclockwise directions. This method of subdividing the stream and generating striations leads to highly

efficient and repeatable mixing with minimal pressure loss. During turbulent flow, the baffles enhance the random motion of molecules and the formation of eddies. In most water and wastewater processes, four or six elements are more than sufficient to completely disperse treatment chemicals and create a very uniform solution or suspension.

Small LPD/LLPD mixers of 1 in. through 2.5 in. in diameter are welded to a central rod, while larger elements are welded to four outside support rods for maximum rigidity and stability. Available in a wide range of sizes up to 48 in. in diameter, these mixers can be supplied as pipe inserts or as complete modules with housing and injection ports.

In addition to Static Mixers, Ross also manufactures High Shear Mixers and Multi-Shaft Mixers used in the production of water treatment chemicals. The company offers no-charge mixer testing services and an extensive trial/rental program.

www.mixers.com

Peristaltic Dosing Pumps Meet the Challenge of Delivering Dirty Fluids and Chemicals that Off-Gas

Peristaltic metering pumps excel at pumping dirty fluids that contain particulate matter into lower pressure systems because they have no check valves to clog; and the gentle forces created during the peristaltic pumping action will not damage delicate fluids within the tube.

Peristaltic pumps are also extremely effective when pumping fluids that contain trapped gases. Chemicals such as chlorine and hydrogen peroxide tend to release absorbed or occluded gases when subjected to a vacuum or changes in temperatures. With peristaltic pumps the bubbles are simply pumped through the pump tube, eliminating the possibility of vapor lock and loss of prime.

In addition, peristaltic pumps are capable of injecting into a vacuum without the need for metal spring loaded valves. Their output volume does not change due to changes in system pressure.

Peristaltic pumps easily prime under maximum pressure, but can be limited to maximum discharge pressures of around 125 psi.

An energy company located in Florida needed pumps to inject 12.5% sodium hypochlorite into reuse water to prevent biological build up within the water tubes of their condenser. Any build up within the condenser would greatly reduce efficiency to pro-

duce steam, hence less mechanical power.

The company chose a CHEM-FEED Duplex Skid System equipped with two of Blue-White's FLEXFLO Peristaltic Chemical Dosing Pumps. The peristaltic pumps maintained their flow without losing prime.

Although peristaltic pumps require almost no regular maintenance, pump tubes degrade and must occasionally be inspected and replaced. Blue-White's exclusive, patented Multi-Tube Technology provides optimal performance and tube life while operating at much higher pressures than conventional single tube designs. The Multi-Tube design delivers tube life up to four times longer than average single tubes.

All of the company's Peristaltic Pumps are equipped with a patented, built-in Tube Failure Detection System (TFD). This technology detects a wide range of conductive chemicals with no false triggering. If the TFD detects tube failure, the pump will automatically shut off and energize a relay switch. This permits communication with external equipment, such as a back-up pump or alarm. It also serves to prevent chemical spills and added downtime.

In conclusion, peristaltic metering pumps have proven to be accurate, dependable, and tough in a multitude of commercial, industrial, and municipal chemical metering applications. They are an excellent choice when pumping fluids that contain particulates or trapped gasses.

www.blue-white.com



Water Reclamation Plant Saves Energy Switching to FLEXERAMIC® Structured Packing

The Buckman Water Reclamation Facility (WRF) in Jacksonville, Florida, faced a significant challenge in its wastewater treatment process due to clogs in the monolith packing used in its regenerative thermal oxidizer (RTO). This clogging impacted the system's efficiency, increased energy consumption and increased downtime for maintenance to clean excessive levels of clogs.

The problems stem from behavior on the atomic level. Today's personal care products increasingly rely on silicone, an ingredient found in shampoos, soaps, oils and some pharmaceutical items, to name a few. These products move through wastewater to treatment plants.

The silicon atoms in the silicone combine with oxygen to form silica fume. Because this is the same material used in a variety of ceramic coatings, the natural tendency is for the silica fume to adhere to the ceramic media. As it builds up over time, it reduces the void space in the media and increases the pressure drop of the process gas through the RTO.

Void space within a monolithic block is confined to narrow vertical channels that

run parallel to each other over the entirety of the block. These channels are often a scant quarter inch in width, and as the void space decreases, the channels plug up. As a result, the RTO could not effectively handle the waste gases from the dryer, reducing its effectiveness in burning off air pollutants and odors while also requiring frequent cleanouts.

To address this challenge, JEA, the publicly owned utility operating the facility, sought a solution from Knight Material Technologies, known for its environmental heat transfer packing materials designed to avoid issues from clogging and high pressure drop when handling corrosive or inorganic materials.

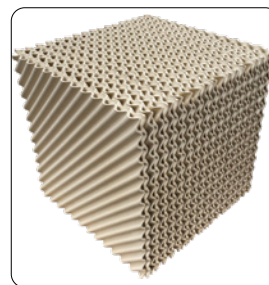
Knight Material Technologies proposed replacing the traditional monolithic blocks with its FLEXERAMIC® Type 28 Structured Packing in one of the three cells within the RTO. The FLEXERAMIC structured packing features a proprietary geometric pattern comprised of corrugated ceramic sheets, allowing for alternate pathways and greater ceramic media surface area than a monolithic design. The multiple alternative air-

flow pathways enable gases to bypass areas that might become clogged by silica oxidation.

The JEA operators conducted a six-month testing period, running the unit with the monolithic and FLEXERAMIC structured packing to evaluate the difference between the two types of structured packing.

The FLEXERAMIC structured packing provided greater airflow (throughput) and required less frequent cleaning. After examining the results, JEA replaced the packing in the remaining two cells within the tower with FLEXERAMIC structured packing. Cleaning cycles were significantly reduced from every three weeks to every four months.

In addition, the facility also reduced its gas usage due to increased energy. This combination of labor and energy savings adds up to a significant return on investment.



www.knightmaterials.com

The Benefits of Using a Tubular Drag Conveyor for Wastewater Treatment

Wastewater treatment is essential for maintaining a healthy and safe environment. In the water/wastewater industry, the use of tubular drag conveyors can be a great asset when managing sludge and biosolids. They offer reliable and efficient solutions for waste handling that can help facilities reduce waste, increase production, and improve safety.

Tubular drag conveyors are built with a closed loop chain which moves material through enclosed tubes or pipes in an uninterrupted flow. This type of conveyor is designed to handle materials that require gentle handling, and are generally considered hard to convey. The chains themselves are designed for durability and can handle material with high abrasion and temperatures. This makes them ideal for use in the wastewater industry, where the materials being handled can be abrasive and/or potentially hazardous.

Tubular drag conveyors offer a number of advantages over traditional conveyance systems. For starters, they are much quieter than other conveying equipment since their enclosed tubes keep noise levels low.

They offer extremely efficient transfer rates and can transport large quantities of material quickly with low power requirements. Furthermore, their enclosed tubes also help keep the environment safe by eliminating liquid and dust emission.

In addition, tubular drag conveyors are relatively easy to install and maintain. They require minimal maintenance and any repairs can typically be completed quickly and easily. This makes them a great choice for facilities running 24/7 with minimal staff. Furthermore, they are highly customizable and can be adapted to fit any size or shape of the waste stream.

Overall, tubular drag conveyors are an excellent solution for waste handling within water treatment plants. They offer efficient transfer rates, require minimal maintenance, and are fully sealed to prevent exposure to odor and contamination. Furthermore, they are easy to install and highly customizable for unique conveying



needs. If your facility is looking for a reliable and effective way to handle sludge or biosolids, tubular drag conveyors could be the perfect solution.

With over 70 years of experience in the conveying industry, Hapman has become a leader in safe and reliable waste handling solutions. Trust their expert team to find the right solution for your facility today.

Visit Hapman at WEFTEC booth 8715 to see their Tubular Drag Conveyor in person.

www.hapman.com

Europe

special advertising section

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GEA: Pow(d)erful Expertise at POWTECH 2023.

A display of innovation for powder drying & handling and solutions for processing liquids & solids across industries and applications. Hall 2, Booth 2-200.

With an offer that caters for a myriad of industries -like the food, animal feed, pharmaceuticals, chemicals, ceramics, minerals, hard metals, battery materials and basic materials for high-quality plastics, to name some- GEA's unique solutions coupled with high quality manufacturing standards have enabled the company to help customers meet the changing needs of their businesses and remain competitive.

This year at POWTECH, some of the innovative and small-carbon-footprint solutions that will be displayed at GEA's booth include an improved version of GEA's patented spray dryer: the MOBILE MINOR. Now with a new and highly efficient cyclone CEE (Cyclone Extra Efficiency). Robust, reliable and versatile already in its original version, it has a proven record of efficiency thanks to the more than 2500 plants worldwide where it has been installed.

Also on showcase will be GEA sifting solutions -also known as Scan-Vibro Sifters- they are tailor-made to meet the customers' specific requirements and are available with an open or closed design. With the possibility to have a sanitary level or not -according

to the customer's needs, they are an easy operable, trustworthy and low-maintenance solution for a wide variety of processes.

On top of this, GEA Sifters are also cost-effective thanks to their gentle handling that results in reduced product damage, lower losses owing to particles breaking away, improved product consistency (size), less waste and minimal reprocessing. Designed to prevent the contamination of sensitive products, GEA Sifters are suitable for fractionation, control screening, dust and water removal of materials like wood pellets, seeds, minerals, cement, fish flour, fertilizer, recycling, household waste and more.

GEA knows that excellent equipment and plants are only one part of success -this awareness has led the company to offer several options of its service concept "GEA Service - For your continued success" and POWTECH is the perfect occasion to know how GEA makes sure customers are effectively supported throughout the entire life cycle of their installed systems and components exactly the way they need it. From project engineering, installation and commissioning to maintaining and improving



the performance of the customer's plant and equipment, GEA is the ideal business partner when it comes to all things powder.

www.gea.com

High precision continuous Film Casting with Venturi drying system

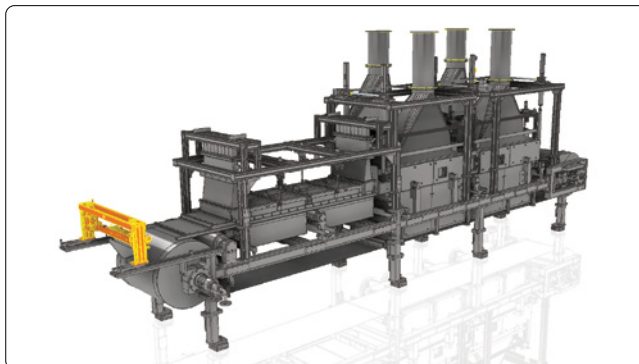
Meeting the demand for high precision thin films with maximum efficiency poses a significant challenge, for instance in industries like ceramics, optical films, fuel cells and energy storage technology. IPCO offers customized process solutions with its continuous Film Casting unit.



Film Casting pilot line

The central element of the IPCO Film Casting process is a continuously running stainless steel belt. A liquid product is applied on the steel belt. As the liquid film is transported through a series of carefully controlled drying segments, the contained solvent is removed. The dried product can be released directly from the belt, eliminating the need for disposable carrier materials.

The drying process is enhanced by heating the steel belt, which



Dry film on steel belt

enables heat transfer to the bottom of the product in addition to the heat supplied by the air above. The patented Venturi dryer segment ensures that skin formation on sensitive product surfaces is avoided. This unique setup allows for a significant reduction in dryer length compared to conventional dryer systems.

The new pilot line in the Productivity Centre, located in Fellbach, Germany, offers customers the opportunity to conduct trials. This unit can handle products with a width of up to 500 mm and achieve dry film thicknesses as low as 6 µm. With the experience gained from trials, along with insights from customers and IPCO's skilled process engineers, the plant design can be optimized to perfectly match the specific requirements of each customer's products.

www.ipco.com

Rethinking LiB electrodes

Manufacturers of energy storage systems are currently focused on two primary objectives: minimizing CO₂ emissions and reducing costs. This drive for efficiency centers on electrode production, which is undergoing significant technological shifts. Dry electrodes, offering notable economic advantages, are gaining traction, and Maschinenfabrik Gustav Eirich stands out as a recommended technology partner for its expertise in slurry production efficiency.

Efforts to cut costs and emissions continue to evolve, with dry electrode production emerging as a key avenue. This method presents opportunities to decrease energy consumption, lower CO₂ output, reduce production expenses, and optimize resource utilization. This has led to an accelerated pace of research and development in the realm of dry electrodes.

Two distinct processes are vying for dominance in dry electrode production, each at differing levels of technological maturity:

1. The first involves creating an electrode mixture and applying it as powder through methods like spraying, brushing, or electrostatics. This is followed by hot calendering.
2. The second process entails generating an electrode mixture with superimposed PTFE fibrillation. This creates a moldable, elastic mixture that's shaped into a free-standing film through calendering, subsequently laminated to a substrate.

Both approaches require structured electrode mixtures featur-



ing conductive carbon blacks coated onto active material particles. Binders, distributed within the mixture via controlled temperature, form a web-like structure after digestion.

Dry electrode production eliminates conventional coating and drying stages. Instead, modified heated multi-roll calenders process the electrode mixtures, obviating the need for liquid solvents and their

associated processing steps. Unlike wet electrode production, this process negates lengthy drying sections, extensive air-handling infrastructure, and recycling facilities for solvents.

By adopting Eirich mixers, a practical solution emerges. Unlike planetary mixers with limited die speeds, Eirich mixers are well-suited for structured electrode mixture production, operating at speeds up to 45 m/s. They facilitate a distinct mixing process where the plastic phase undergoes hard kneading for dispersion and property adjustment. These mixers accommodate varying consistencies, allowing the plastic mixture to transform into a granular form conducive to conveyance and calibration.

For those transitioning from wet to dry electrode production, the versatility of Eirich mixers shines. These machines are adaptable from a wet processing setup, like MixSolvers, to a dry electrode production mode with minor adjustments. Thus, users of Eirich mixing technology possess future-proof solutions, irrespective of the eventual dominance of dry or wet electrode production methodologies.

www.eirich.de

5G innovations for ex environments

First 5G smartphone for ATEX Zone 1/21 IS540.1 from i.safe MOBILE is a game changer for chemical industry

With the rapid transition to 5G technology and the use of compatible mobile devices such as the IS540.1, companies can finally digitise their production and processes for remote maintenance, IIOT and augmented reality, even in sensitive ex zones. The 5G concept offers advantages for new automation applications and for machine-to-machine communication, as large amounts of data are exchanged almost in real time with minimal latency. Areas of application for the new industrial smartphone IS540.1 from i.safe MOBILE are scenarios in explosion hazardous areas such as control/monitoring of mobile robots, autonomous campus driving and platooning (automated column driving) near-real-time monitoring in process automation, workflow in the control loop and in plant control, asset tracking, access control and logistics management.

The 5G industry smartphone IS540.1 from i.safe MOBILE supports customers of the chemical industry for process changes due to the transition from 4G/LTE to 5G, such as PoC/video PTT, automation, augmented reality and predictive maintenance. With a powerful Qualcomm® QCM6490 chipset, the smartphone has high-performance AI and computing capabilities, while the 48MP main camera ensures high image quality. The IS540.1 further features a clear 6-inch display, PTT functionality and is equipped with a multifunctional ISM interface and a powerful speaker. Dual Band Wi-Fi 6 (with 2.4 and 5 GHz support) connectivity enables additional efficiency gains, faster data transmission at higher data rates in industrial communications.

Around 3000 customers worldwide, including Fortune 500 companies, rely on i.safe MOBILE's products, customised software and service solutions certified to international standards such as ATEX, IECEx and NEC 500. i.safe MOBILE is certified Android Enterprise Silver Partner in the Android Enterprise Partner Program initiated by Google.

www.isafe-mobile.com



Thin Films in Large Devices

Thin film evaporators of Buss-SMS-Canzler

The separation of volatile components from a solution is a common task for many chemical processes. Especially in case of thermal sensitive products, a thin film evaporator offers a good possibility to attack the task.



In general, a thin film evaporator consists of a rotor and a heated cylindrical jacket. This seems rather simple, however, to achieve an effective evaporation and to get a product of high purity, many details need to be considered. Two main challenges appear to guarantee an effective process and a high-quality product.

The first challenge is to distribute the incoming feed out of a pipe as evenly as possible on the heated jacket. A fast and

even distribution of the feed on the jacket guarantees an efficient use of the heated wall and leads to a maximum evaporation. During the distribution process no droplets should be generated to prevent the contamination of the distillate. Buss-SMS-Canzler developed distributors for thin film evaporators, as well as for short path evaporators, to fulfill both demands by means of computational fluid dynamics.

The second challenge is to choose the right blades for the rotor, depending on the physical properties of the liquid. Especially when chemical reactions or particles in the liquid must be taken into account. The blades shall lead to an optimal contact of the liquid and the heated wall to maximise the evaporation rate. They can also reduce the effect of fouling or incrustations. The properties of the different blades, offered by Buss-SMS-Canzler, have been investigated by computational fluid dynamics too, to better understand their effects on the thin film.

The usage of modern tools and methods in combination with their years of experience enable Buss-SMS-Canzler to design high-quality and effective devices.

www.sms-vt.com/

POWTECH 2023: Perfect solutions in bulk materials handling

From September 26 to 28, Friedrichshafen-based plant manufacturer Zeppelin Systems will be presenting a wide range of products and services in the field of material handling together with Magdalena KITZMANN GmbH (Zeppelin Systems holds a majority stake) at POWTECH in Nuremberg.



From mixers to silos, components in pneumatic conveying systems, smart control concepts to the production of turnkey plants and after-sales service: The Zeppelin Systems and KITZMANN partnership offers a symbiosis that is one-of-a-kind worldwide in regards to in-house production depth. Process plants as well as mixers, silos and components are manufactured in-house in order to consistently and sustainably meet customers' high-quality demands.

Zeppelin Systems underlines the customer and service promise "We Create Solutions" by continuously adapting and further developing its products. This is also the case with the rotary sifter RS 7, which

will be on display as an exhibit at POWTECH: It can now be equipped with the new, blue screen mesh from Zeppelin Systems. Filter fragments due to abrasion or wear are thus reliably identified and absolute food safety is guaranteed. The rotary sifter RS is used in the food, chemical, plastics

processing and pharmaceutical industries and is used both as a pre-screen in front of silos or in pour-in stations and as a post-screen under bins and as an inline screener for pressure-tight operation in pneumatic conveying systems.

"As an integrated solution provider in plant engineering, we find the right process, machine, components, or turnkey plant engineering solution for every customer challenge," says Hubert Stojanovic, Vice President Performance Materials at Zeppelin Systems GmbH. Find out how we can create solutions for you too, visiting us in Hall 4 at stand 4-524. We Create Solutions! www.zeppelin-systems.com

In the anniversary year 2023 – Phoenix Contact is celebrating the 100th anniversary of the company's founding

A century of passion for technology and innovation: In 100 years, the family-owned company Phoenix Contact has evolved from a commercial agency for industrial products founded in Essen into a global manufacturing company. With products and solutions for electrification, networking, and automation in all sectors of the economy and infrastructure - and with a passion for innovation and technology.

“Together, we have achieved a great deal over these years, remaining true to the values and culture of our family business despite growth and further development. This anniversary is a special moment for us. We have built the foundation on which we can now continue on our path into the future. Together with our customers and business partners, we will drive forward solutions for the energy revolution that are the basis for a sustainable world,” says Frank Stührenberg, CEO Phoenix Contact, describing the significance of the 100th anniversary.

Connections of people and technologies

Good connections are not only elementary in Phoenix Contact's products they have also given rise to a globally active industrial company from the idea of businessman Hugo Knümann. With the founding of Phönix Elektro- und Industrie-Bedarfsgesellschaft in Essen in 1923, the company initially started out as a pure sales company. In 1928, the business connection with RWE led to the invention of the



first terminal block on a DIN rail. In 1949, Knümann met Josef Eisert, a development engineer at Siemens, who took over the company in 1953 after Knümann's death.

From Blomberg to the world

A pure sales company becomes a company with its own production. At the location in Blomberg, to which the company had to be relocated during the war, tool shop, plastics production, screwdriver shop, assembly, locksmith's shop, warehouse and shipping department were soon established. With the innovative fieldbus system Interbus, the basis for industrial networking follows in 1987. After the foundation of the first foreign subsidiary in the USA in 1981, more than 50 subsidiaries follow all over the world.

Together for the future

Today, Phoenix Contact employs around 22,000 people and has generated sales of 3.6 billion euros in 2022. Worldwide, production is carried out in a manufacturing network in 11 countries with varying degrees of vertical integration. Together with customers and partners, Phoenix Contact develops solutions for the world of tomorrow with trend-setting connection and automation technology. The holistic concepts including engineering and services are used, for example, in transportation infrastructure, e-mobility, clean water, regenerative energies and intelligent supply networks or in energy-efficient machine building and systems manufacturing.

Social responsibility

Phoenix Contact is committed to paving the way for the “All Electric Society,” a future in which energy from renewable resources is available everywhere in sufficient quantities in an economical and sustainable manner. Furthermore, reducing overall energy demand through efficiency measures and creating intelligent and networked systems through sector coupling is key to this sustainable future.

www.phoenixcontact.com

Compact Heavy-Duty Coriolis Flow Meter

FOR LOW FLOW RATES

Bronkhorst High-Tech, specialist in low flow measurement and control technology, presents a new, compact, and robust Coriolis mass flow meter. The mini CORI-FLOW M100 series integrates an innovative flow sensor and electronics into a weather-proof housing, equipped with cable glands and screw terminals, suitable for industrial applications.

This reliable meter utilizes integrated optical sensor technology, ensuring highly precise measurement of extremely low gas and liquid flows, ranging from 1 g/h to 30 kg/h. As a standard feature, the flow meter includes an integrated PID controller, allowing for

the creation of a compact flow control system when combined with a close-coupled pump or valve. The instrument also offers additional functionalities, such as alarms and counters, and boasts extensive connectivity options supporting RS232/RS485, Industrial Ethernet, or analog I/O for seamless integration into any system.

www.bronkhorst.com



store.CHEMENGONLINE.com

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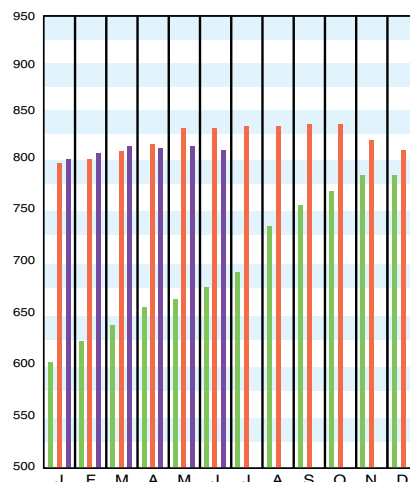
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Download the CEPCI two weeks sooner at www.chemengonline.com/pci

CHEMICAL ENGINEERING PLANT COST INDEX (CEPCI)

(1957-59 = 100)	June '23 Prelim.	May '23 Final	June '22 Final	Annual Index:
CE Index	803.2	808.8	832.6	2015 = 556.8
Equipment	1,012.9	1,021.3	1,058.7	2016 = 541.7
Heat exchangers & tanks	835.5	841.6	897.2	2017 = 567.5
Process machinery	1,034.0	1,033.8	1,074.4	2018 = 603.1
Pipe, valves & fittings	1,365.6	1,399.8	1,497.0	2019 = 607.5
Process instruments	562.7	564.5	570.5	2020 = 596.2
Pumps & compressors	1,443.1	1,438.3	1,285.2	2021 = 708.8
Electrical equipment	799.0	796.4	767.9	2022 = 816.0
Structural supports & misc.	1,142.3	1,147.6	1,189.8	
Construction labor	364.5	364.6	355.8	
Buildings	817.0	818.2	840.6	
Engineering & supervision	313.8	314.4	312.2	

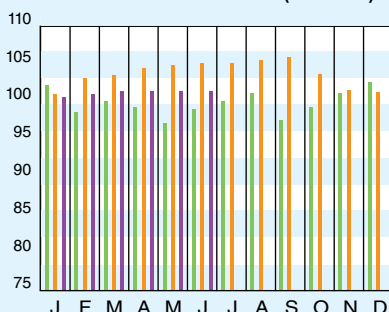
Starting in April 2007, several data series for labor and compressors were converted to accommodate series IDs discontinued by the U.S. Bureau of Labor Statistics (BLS). Starting in March 2018, the data series for chemical industry special machinery was replaced because the series was discontinued by BLS (see *Chem. Eng.*, April 2018, p. 76-77.)



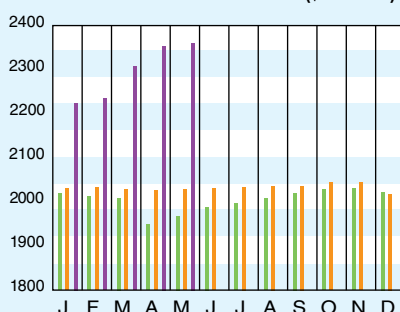
CURRENT BUSINESS INDICATORS

	LATEST	PREVIOUS	YEAR AGO
CPI output index (2017 = 100)	Jun. '23 = 99.8	May '23 = 99.8	Apr. '23 = 100.0
CPI value of output, \$ billions	May '23 = 2,307.3	Apr. '23 = 2,344.4	Mar. '23 = 2,360.3
CPI operating rate, %	Jun. '23 = 79.6	May '23 = 79.6	Apr. '23 = 79.9
Producer prices, industrial chemicals (1982 = 100)	Jun. '23 = 313.9	May '23 = 322.6	Apr. '23 = 329.0
Industrial Production in Manufacturing (2017 = 100)*	Jun. '23 = 99.6	May '23 = 99.9	Apr. '23 = 100.1
Hourly earnings index, chemical & allied products (1992 = 100)	May '23 = 219.0	Apr. '23 = 219.5	Mar. '23 = 216.9
Productivity index, chemicals & allied products (1992 = 100)	Jun. '23 = 91.5	May '23 = 91.2	Apr. '23 = 91.5
			Jun. '22 = 100.8
			May '22 = 2,550.0
			Jun. '22 = 81.4
			Jun. '22 = 379.4
			Jun. '22 = 100.0
			May '22 = 201.0
			Jun. '22 = 91.4

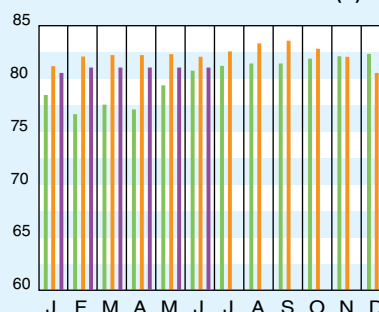
CPI OUTPUT INDEX (2017 = 100)†



CPI OUTPUT VALUE (\$ BILLIONS)



CPI OPERATING RATE (%)



*Due to discontinuance, the Index of Industrial Activity has been replaced by the Industrial Production in Manufacturing index from the U.S. Federal Reserve Board.
†For the current month's CPI output index values, the base year was changed from 2012 to 2017.
Current business indicators provided by Global Insight, Inc., Lexington, Mass.

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CURRENT TRENDS

The preliminary value for the CE Plant Cost Index (CEPCI; top) for June 2023 (most recent available) fell compared to the previous month, reversing an upward trend over the previous two data cycles. In June, all four of the subindices — Equipment; Buildings; Construction Labor; and Engineering & Supervision — saw declines, with the largest decrease being observed for the Equipment subindex. The current CEPCI value now sits at 3.5% lower than the corresponding value from June 2022. Meanwhile, the Current Business Indicators (middle) show no change in the CPI output index and the CPI operating rate for June 2023, and a small decrease in the CPI value of output for May 2023.